APPENDIX B
CONSTRUCTION ACTIVITIES AND DRAWINGS

OVERHEAD LINES

Soil Boring

Soil is bored and analyzed along the transmission line alignment to determine the engineering properties of the soil for purposes of designing the line. Borings would be made at approximately 1 mile intervals using track-mounted equipment. Where steel poles are used, the intervals between soil borings may be less than 1 mile, depending on variations in soil types along the route. The borings would be approximately 4 inches in diameter, range from 20 to 50 feet deep, and backfilled with the excavated material upon completion of soil sampling. To minimize ground disturbance, borings would be made adjacent to existing access roads whenever possible.

Surveying

Surveying would be accomplished by a combination of aerial and ground survey methods. Ground surveying would be required in areas of heavy vegetation and where aerial methods are more expensive. Surveying on the right-of-way would be required for locating structures and soil borings. Survey work on the right-of-way would involve limited cutting of trees and vegetation for line-of-sight staking and distance measuring. No new access would be needed during surveying, since only survey crews and their equipment would be involved. Section and quarter-section corners would be located. The edges of the right-of-way would be staked in areas where clearing for construction is required. Some structure locations may have to be re-staked by the surveyors if the survey markers are destroyed by clearing.

Clearing

To allow continued reliable operation of the line, clearing of trees from the right-of-way would be required to prevent potential outages caused by trees contacting the energized conductors. The amount of clearing is dependent on several variables. In general, it is advantageous to remove as many trees as possible initially to minimize maintenance costs (future clearing of maturing trees). However, complete removal of trees has to be compared with potential impacts in the particular area (e.g., wider clearings in rural locations may be more justifiable than in urban areas where land uses restrict the amount of clearing). Right-of-way clearing would be done mechanically, except in sensitive areas where hand clearing may be appropriate. Herbicides would not be used for vegetation control along the right-of-way.

In rural areas, the entire 150-foot-wide right-of-way would be cleared of trees except for areas exhibiting special conditions. Figures B-1 through B-5 illustrate clearing. In areas where special conditions exist, the area cleared could be reduced. At a minimum, any trees that would directly contact the conductor, with consideration for the next five years of growth, would be removed.

Fast growing trees under and between the conductors as well as those within approximately 20 feet of the conductor movement envelope would be removed.

In urban areas, right-of-way normally would be restricted by existing facilities such as roadways, private property, and homes. The line is typically located in a reduced right-of-way and tree clearing is more difficult due to landowner objections to clear cutting and removal of danger trees. Single pole structures would minimize conductor spacing and thereby require less clearing (Figure B-6). A minimum 40-foot-wide right-of-way is expected. Wherever possible, the full width of the right-of-way would be cleared of trees. It is often necessary to reduce the visual effects of power lines by screening. However, tree limbs reaching into the right-of-way and in danger of contacting the line would be removed. This method of clearing results in higher costs and more frequent right-of-way maintenance.

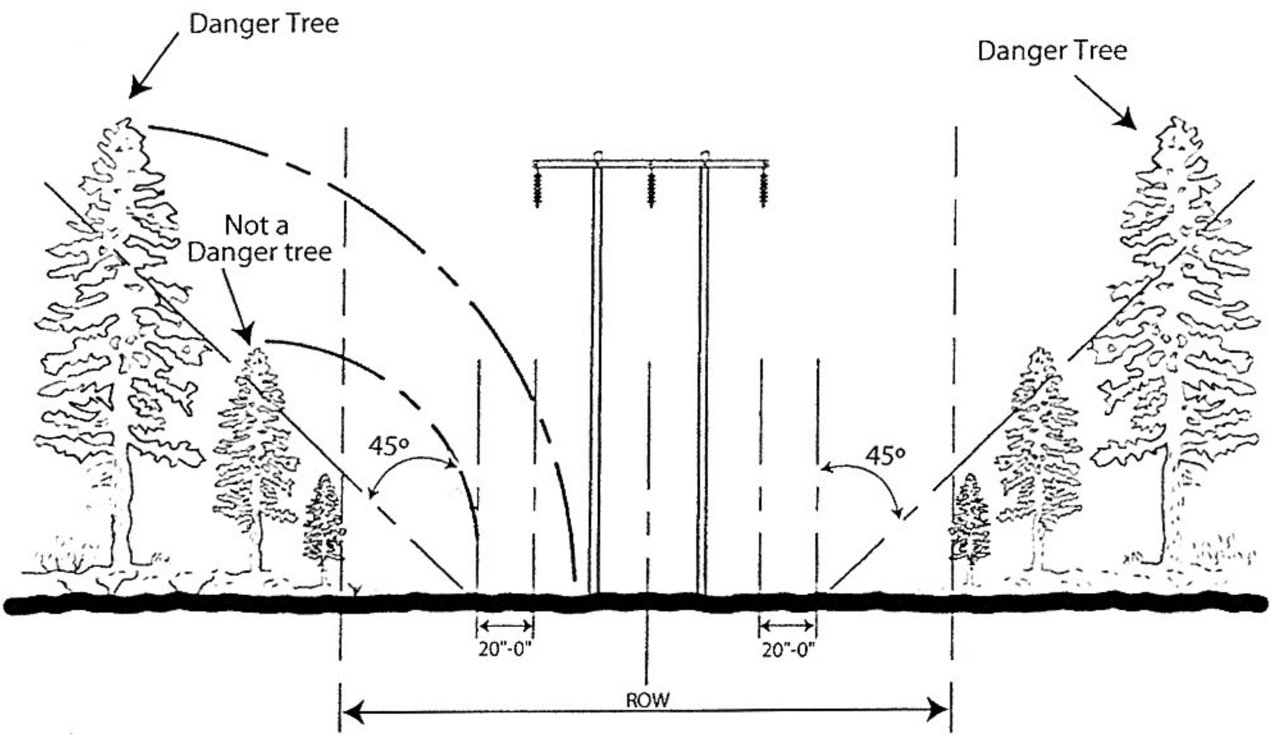
In both rural and urban areas, it is standard practice to remove trees outside the right-of-way that would endanger the line should the trees fall over (danger trees). Typically these trees are tall and exhibit some defect that indicates future problems. Danger trees outside the right-of-way and trees on the right-of-way would be cut as close to the ground as possible, with stump height not exceeding 6 inches above surrounding ground level.

Special conditions would be considered individually. Typical examples include leaving existing vegetation screens at road and river crossings, spanning over special vegetation where possible, and hand clearing in areas sensitive to equipment.

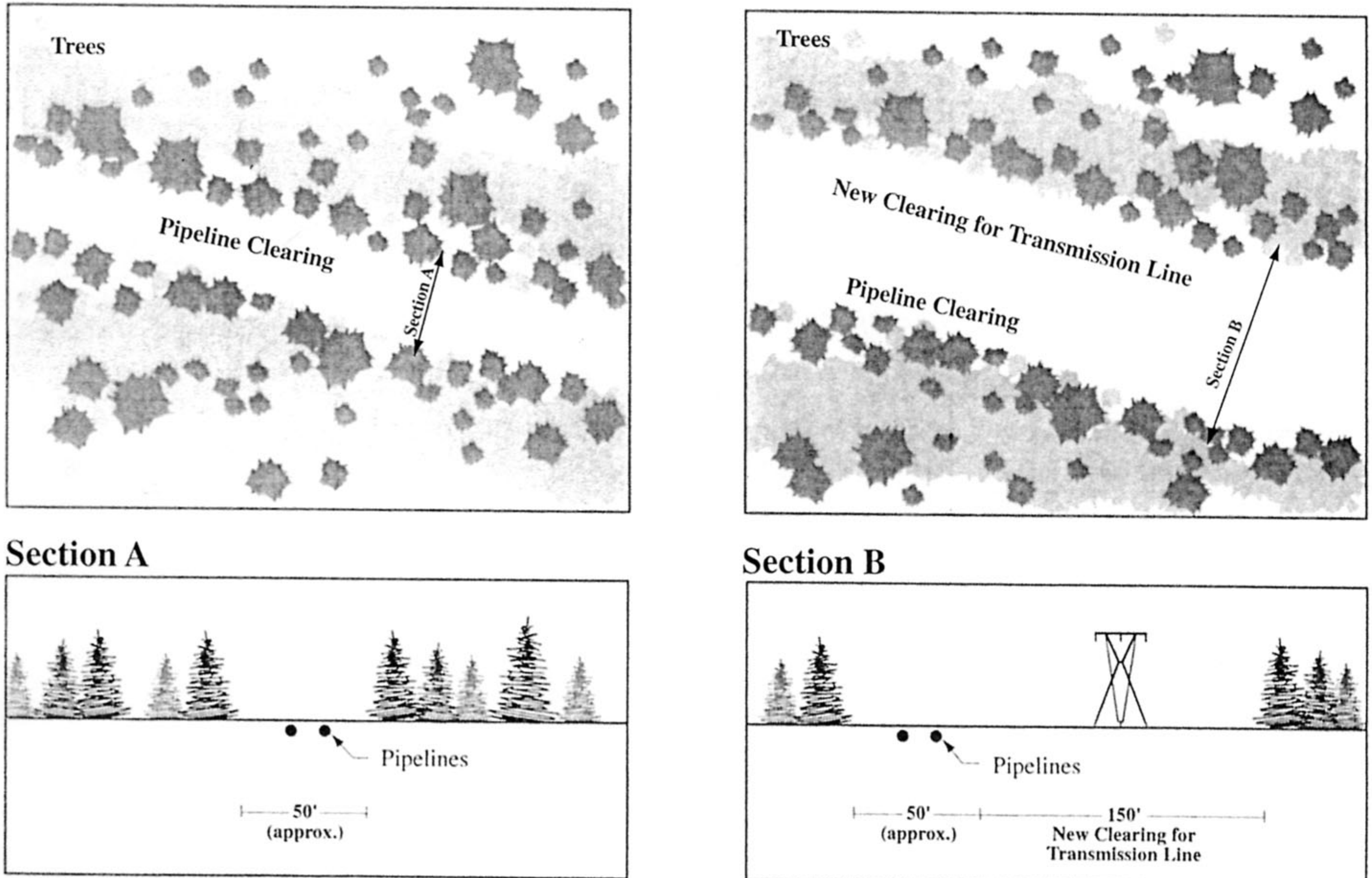
To mitigate concerns for spruce bark beetle infestation, options for removing trees, at the direction of the landowner, will be chipping, scattering, or burning. Cleared debris would be disposed of in compliance with local ordinances and in accordance with the landowner's request. Gates would be installed, as required, in existing fences located on the right-of-way to facilitate construction access. Existing fences and gates would be grounded.

Foundation Installation

There are two types of foundations for the X-towers or H-frame structures, driven piling or augured holes (Figure B-7). Driven piling generally would be made with truck- or track-mounted pile driving equipment. This type of foundation was commonly used for many of the more recent transmission lines in Alaska. In some instances, an augured hole may be required to place a piling instead of driving it. This type of foundation generally would be made with a truck- or track-mounted auger. The same or similar equipment would be required for all wood pole installations. An alternative to using truck- or track-mounted auger equipment would be to use smaller auger equipment, flown to each site by helicopter. Helicopters are sometimes used in areas without existing access. However, since there are existing access trails or roads along the routes, helicopter transport of augering equipment is not proposed for the Project. Table B-1 tabulates the construction methods proposed by link, for each route.

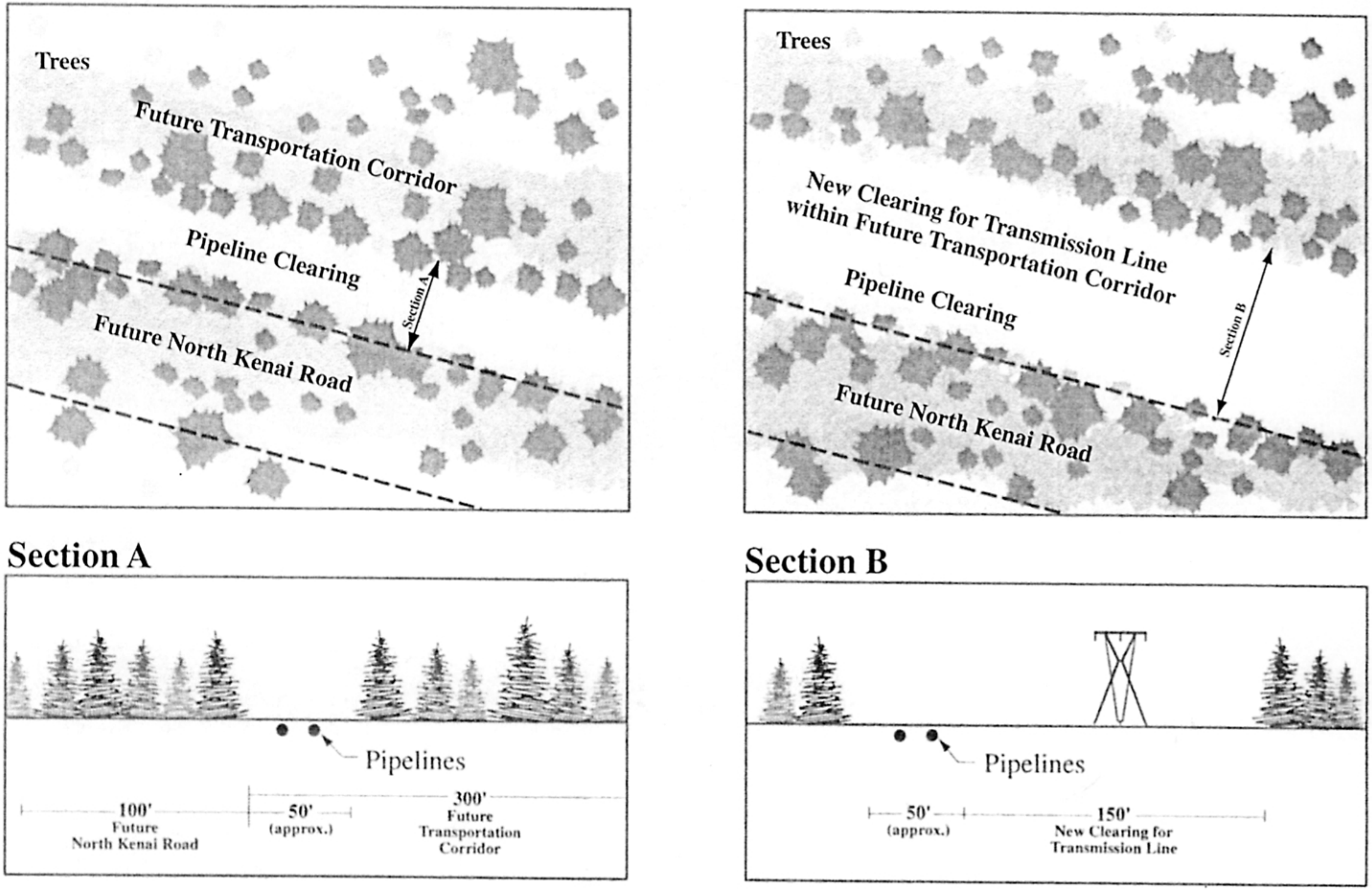


Typical Right-of-way Clearing for Rural Areas
Southern Intertie Project
Figure B-1



Not to scale

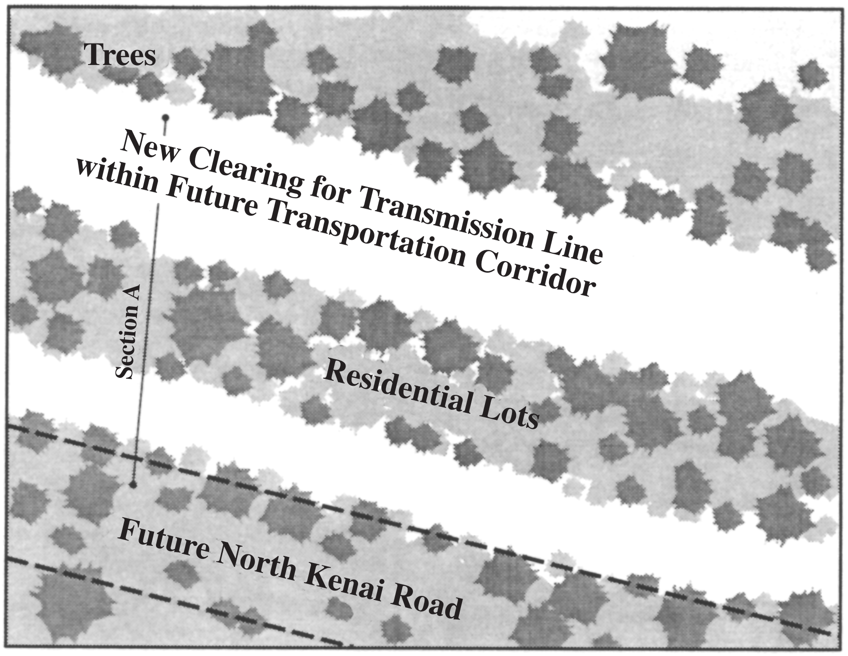
Right-of-way Clearing for Enstar Route
Southern Intertie Project
Figure B-2



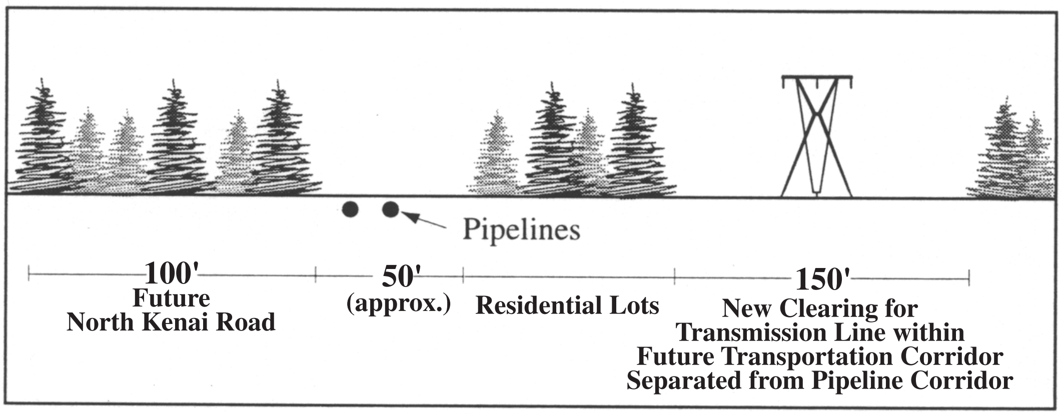
Right-of-way Clearing for Tesoro Route Adjacent to Future North Kenai Road

Southern Intertie Project

Figure B-3



Section A

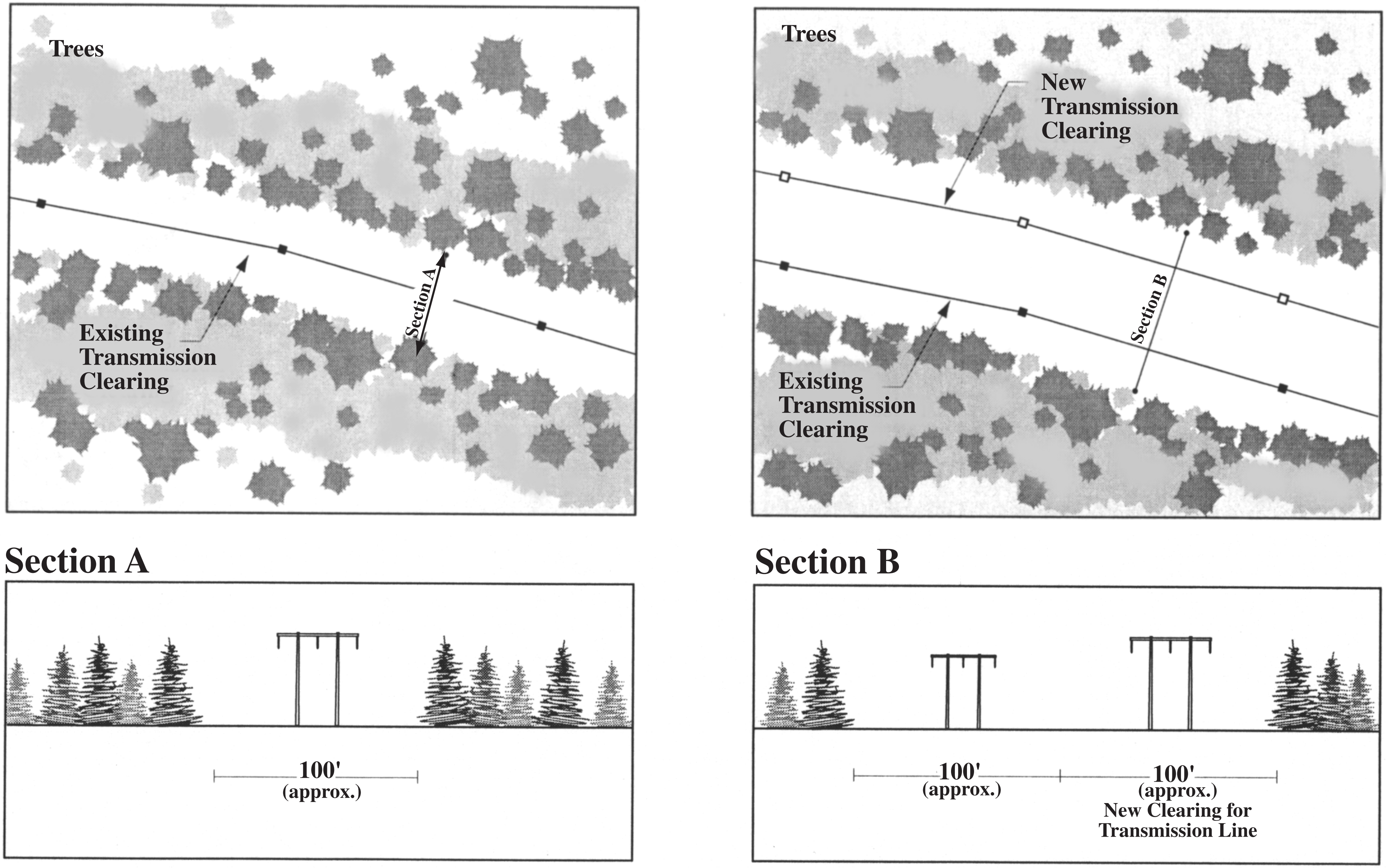


Not to scale

Right-of-way Clearing for Tesoro Route Separated from
Future North Kenai Road

Southern Intertie Project

Figure B-4

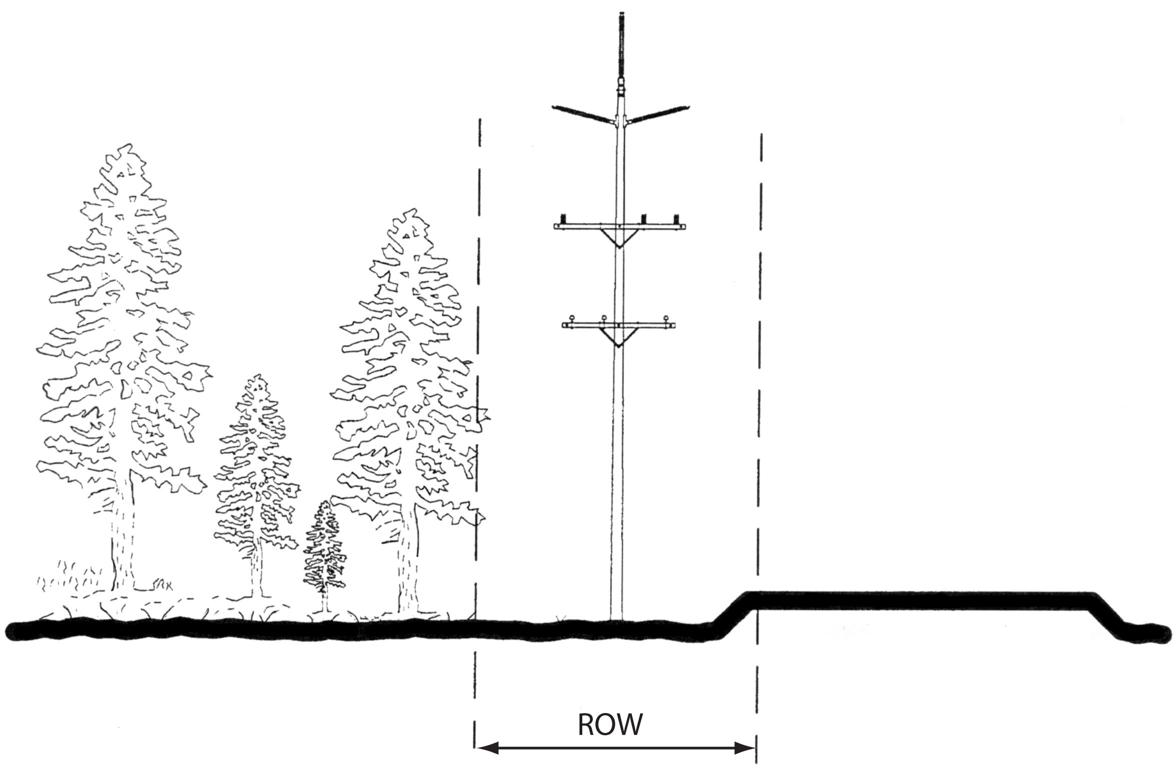


Not to scale

Right-of-way Clearing Adjacent to Existing Transmission Line

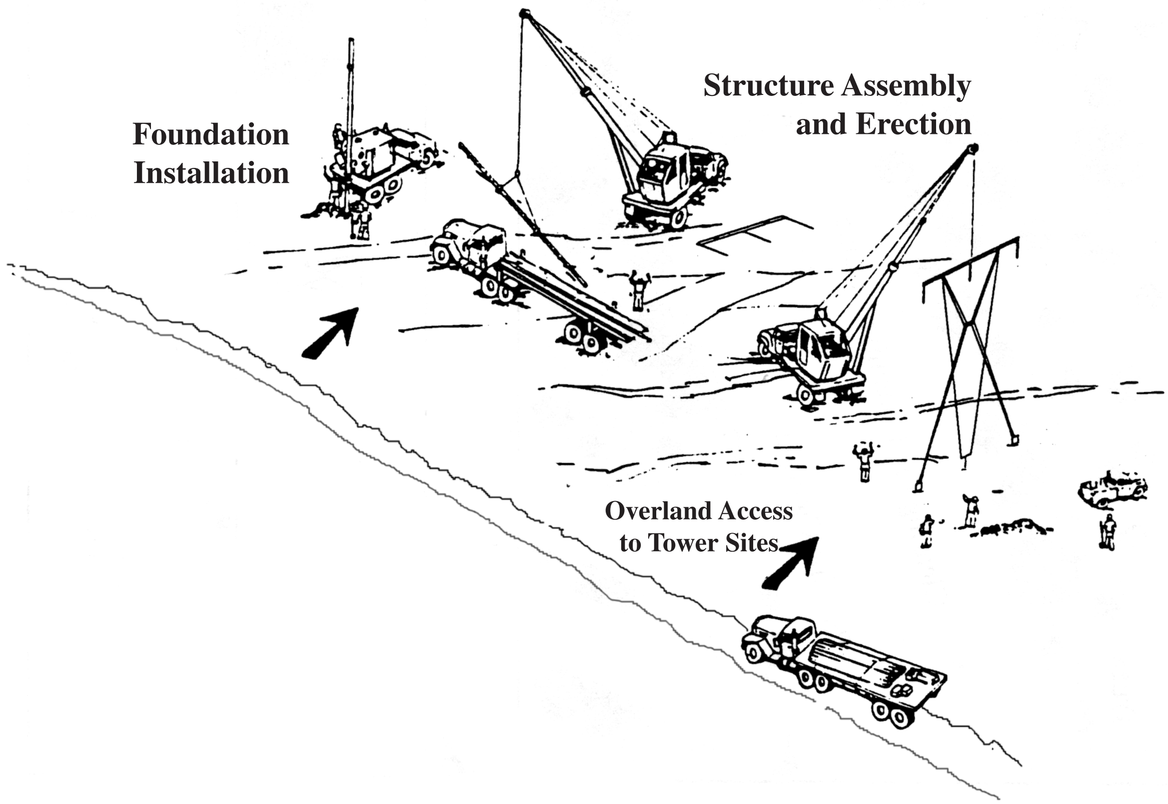
Southern Intertie Project

Figure B-5

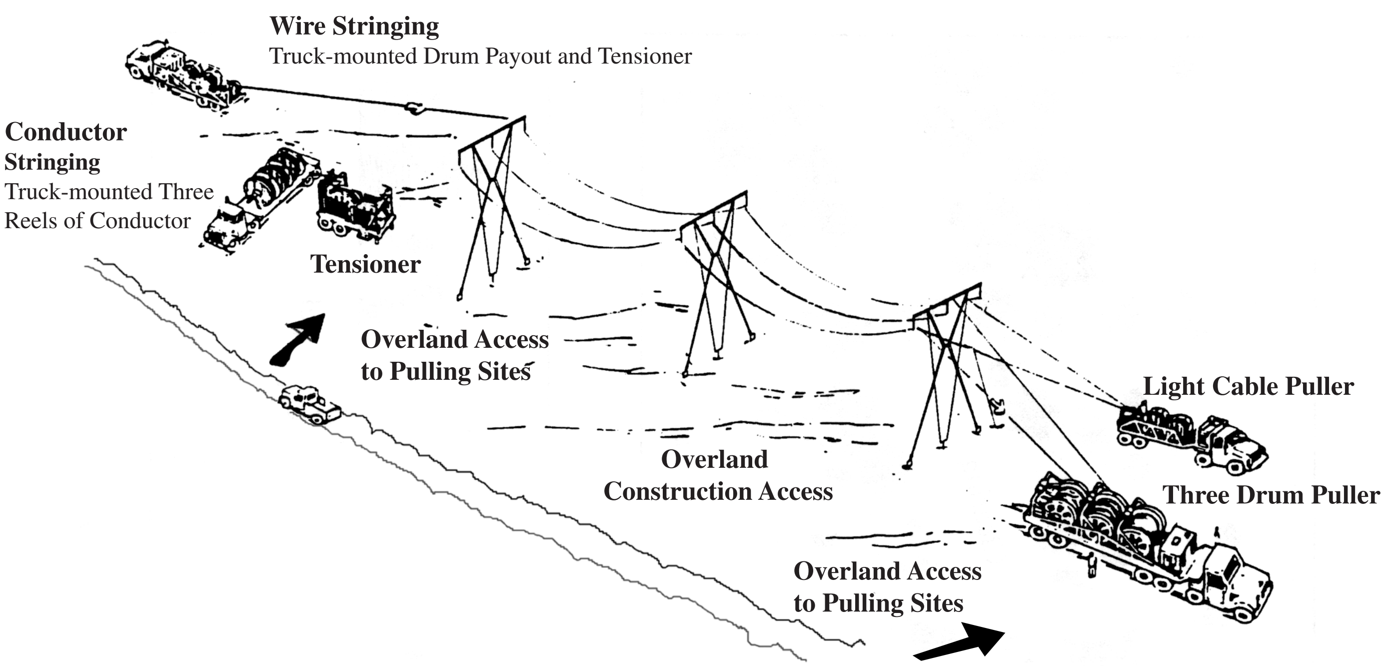


Typical Right-of-way Clearing for Urban Areas
Southern Intertie Project
Figure B-6

Foundation and Structure Construction Activities



Conductor Stringing Activities



Typical Construction Activities - Tesoro or Enstar Routes

Southern Intertie Project

Proposed Anchorage to Kenai Peninsula Transmission Line

Figure B-7

Links	From MP	To MP	Miles Crossed	Existing Right-of-Way Use Paralleled	Location of Proposed Line	Separation Between Existing and Proposed Facilities (feet)	Adjacent Uses	Proposed Right-of-Way or Easement Width (feet)	Access to Area: Existing Access	Access to Area: New Access Required	Construction Methods	Construction Timing (season)	Operation and Maintenance
Kenai Lowlands													
E4	0.0	0.7	0.7	(2) pipelines	parallel - east side	100	undeveloped	150	FWD road	no	1	Summer	1,3
E7	0.0	0.3	0.3	---	---	N/A	undeveloped	150	none	yes	8	Summer	1,3
E8	0.0	33.1	33.1	(2) pipelines	parallel - east side	100	undeveloped	150	FWD trail	no	1	Winter/Summer	1,2,3,4
E9	0.0	1.0	1.0	(2) pipelines	parallel - east side	100	moderate mgmt.	150	FWD trail	no	1	Winter	1,2,3,4
E9	1.0	3.6	2.6	(2) pipelines	parallel - east side	75	moderate mgmt.	100	FWD trail	no	10^	Winter	1,2,3,4
E10	0.0	1.8	1.8	(2) pipelines	parallel - east side	75	moderate mgmt.	100	FWD trail	no	10^	Winter	1,2,3,4
E1	0.0	0.7	0.7	(2) 115 kV, 69kV	parallel - west side	75	residential	100	gravel road	no	10	Summer	1,3
E1	0.7	1.1	0.4	(2) 115kV	parallel - west side	75	residential	100	gravel road	no	10	Summer	1,3
E2	0.0	0.4	0.4	(2) 115kV	rebuild double circuit	rebuild	residential	rebuild	gravel road	no	9	Summer	1
E3	0.0	1.1	1.1	(2) 115kV	parallel - south side	100	residential	100	FWD road	no	8	Summer	1,2,3
E3	1.1	1.9	0.8	(2) 115kV & 69kV	parallel - south side	100	residential/airstrip	100	FWD road	no	8	Summer	1,2,3
E3	1.9	3.4	1.5	(2) 115kV, 69kV & distribute.	parallel - west side	100	undeveloped	100	FWD road	no	8	Summer	3
E3	3.4	6.5	3.1	115kV, pipeline	parallel - north side	100	native selected/KNWR	100	FWD road	no	8	Summer	3
E3	6.5	19.4	12.9	115kV	parallel - north side	100	native selected/KNWR	100	FWD road	no	8	Summer	1,3
E6	0.0	1.0	1.0	115kV	parallel - east side	100	residential	100	FWD road	no	8	Summer	1,3
E5	0.0	0.3	0.3	(2) 115kV & 69kV	replace 69kV	rebuild	residential	rebuild	gravel road	no	Existing	Summer	1
E5	0.3	2.0	1.7	115kV & 69kV	replace 69kV	rebuild	residential	rebuild	FWD road	no	8	Winter/Summer	3
E5	2.0	6.0	4.0	69kV	replace 69kV	rebuild	residential	rebuild	FWD road	no	8	Winter/Summer	3
E5	6.0	12.0	6.0	69kV	replace 69kV	rebuild	residential	rebuild	FWD road	no	8	Summer	1,3
E5	12.0	13.2	1.2	69kV & (1) distribute.	replace 69kV	rebuild	Bing’s Landing SRS	rebuild	FWD road	no	11*	Summer	1,3
E5	13.2	17.6	4.4	69kV	replace 69kV	rebuild	residential	rebuild	FWD road	no	8	Summer	1,3
T1	0.0	0.2	0.2	115kV & 69kV	parallel	100	industrial	100	paved road	no	13	Summer	1
T2	0.0	0.3	0.3	roadway	parallel - east side **	N/A	industrial	30	paved road	no	13	Summer	1
T3	0.0	1.2	1.2	roadway	parallel - east side	N/A	commercial/residential	30	paved road	no	13	Summer	1
T3	2.1	7.5	5.4	roadway	parallel - east side	N/A	commercial/residential /two airstrips	30	paved road	no	13	Summer	1
T4	0.0	4.7	4.7	roadway	parallel - east side	N/A	residential	30	paved road	no	13	Summer	1
T6	0.0	3.6	3.6	(2) pipelines	parallel - east side	100	residential	150	FWD road	no	3	Winter/Summer	1,3
T7	0.0	9.3	9.3	(2) pipelines	parallel - east side	100	residential	150	FWD road	no	3	Winter	2,3,4
T7	9.3	22.4	13.1	pipeline	parallel - east side	100	Kenai Borough	150	FWD road	no	3	Winter	3,4
Turnagain Arm													
T11	0.0	3.1	3.1	---	new	N/A	CIRI - Vortac	150	none	yes	8	Summer	1,2,4
T12	0.0	1.4	1.4	FWD road	parallel - west side	N/A	CIRI	150	FWD road	no	8	Summer	1,2,4

TABLE B-1
PROJECT DESCRIPTION/OVERHEAD LINE SEGMENTS

Links	From MP	To MP	Miles Crossed	Existing Right-of-Way Use Paralleled	Location of Proposed Line	Separation Between Existing and Proposed Facilities (feet)	Adjacent Uses	Proposed Right-of-Way or Easement Width (feet)	Access to Area: Existing Access	Access to Area: New Access Required	Construction Methods	Construction Timing (season)	Operation and Maintenance
Anchorage Bowl													
A11	1.0	2.9	1.9	roadway	parallel - east side	rebuild	residential	30	paved road	no	14	Summer	1
A7	0.0	0.7	0.7	railroad	parallel - east side	use existing 138kV line within railroad right-of-way	residential	30	gravel RR bed	no	13	Summer	1
A13	0.0	0.7	0.7	roadway	parallel - east side	rebuild	residential	30	paved road	no	15	Summer	1
A20	0.0	0.1	0.1	roadway	parallel - south side	adjacent	industrial	30	gravel road	no	14	Summer	1
A3	0.0	0.5	0.5	roadway	parallel - north side	adjacent	undeveloped	30	paved road/none	yes	13	Summer	1,2
A19	0.0	0.2	0.2	roadway	parallel - south side	adjacent	commercial	30	paved road	no	13	Summer	1
A18	0.0	1.0	1.0	roadway	parallel - south side	adjacent	extraction	30	paved road	no	13	Summer	1
A4	0.0	0.3	0.3	roadway	parallel - south side	adjacent	undeveloped	30	paved road	no	13	Summer	1,2,3
A16	0.0	2.0	2.0	roadway	parallel - north side	adjacent	commercial	30	paved road	no	13	Summer	1
A16	2.0	2.3	0.3	138kV & (2)distribution lines	north side	rebuild Arctic to CEA	residential	30	paved road	no	14	Summer	1
A5	0.0	2.8	2.8	roadway	parallel - west side	adjacent	residential/open space	30	paved road***	no	13	Summer	1,2,3***
A5	2.8	3.0	0.2	(2) distribution lines	parallel - west side	adjacent	industrial	30	paved road***	no	14	Summer	1,2,3***
A5	3.0	3.3	0.3	138kV & (3) distribution lines	parallel - west side	rebuild	industrial	30	gravel road	no	14	Summer	1
A14	0.0	1.5	1.5	roadway	parallel - east side	rebuild	mixed use	30	paved road	no	15	Summer	1
A15	0.0	1.5	1.5	roadway	parallel - east side	rebuild	mixed use	30	paved road	no	15	Summer	1
A8	0.0	1.5	1.5	railroad	parallel - east side	within railroad right-of-way	industrial	30	gravel railroad bed	no	13	Summer	1
A9	0.0	1.8	1.8	railroad	parallel- east side	use existing 138kV line within railroad right-of-way	industrial	30	gravel railroad bed	no	13	Summer	1
A17	0.0	0.3	0.3	roadway	south of shopping center	adjacent	commercial	30	paved road	no	14	Summer	1
A10	0.0	0.5	0.5	railroad	parallel- east side	within railroad right-of-way	industrial	30	gravel railroad bed	no	15	Summer	1

Notes:
* Single pole wood, except for Kenai River crossing on H-Frame.
** Southern Intertie line along east side of road ~ existing lines along west side of North Kenai Spur Road.
*** Access along Minnesota Drive would be from outside the highway right-of-way and along the transmission right-of-way at the highway right-of-way edge. Access would not be from the paved highway.
^ Single wood pole modified for shorter pole heights/spans to reduce clearing and for bird/raptor protection.

Construction Timing
Winter Season – Frozen: November to March
Summer Season – Thawed: April to October
Submarine: May to June

Construction Methods – Operation and Maintenance
1 – Rubber-tired vehicle
2 – Tracked vehicle
3 – Special Equipment
4 – Aerial

Single-shaft steel poles located along roadways generally would be bolted to concrete piers, piling, or directly embedded in the soil. Concrete piers would be placed in augured holes. Steel reinforcing for the concrete foundations would be transported by truck to the structure site, either as a prefabricated cage or as loose bars, which would be fabricated into cages on the site. The reinforcing bar cage then would be placed in the excavation with a crane. Portions of the concrete foundation extending above the ground would be formed. After the foundation has been poured, the forms would be removed, and the surface of the foundation dressed. Concrete would be hauled to the site in concrete trucks. Excavated material normally would be spread at the structure site to match existing ground contours, unless otherwise requested by the landowner, or due to special environmental conditions.

The concrete foundations would have threaded anchor bolts embedded in the concrete. The tubular sections of the poles would be attached to the foundation by means of a baseplate welded to the tubular section and placed on the anchor bolts.

If pipe piling is used to support a single-shaft steel pole, the piling would be transported to the site with equipment similar to that used for handling poles. Installation of the pipe piling would be completed using a pile driver to drive the pile to the required depth. The single-shaft steel pole then would be bolted to a plate attached to the top of the piling. A cluster of H-type piling also could be used to provide a foundation for a steel pole. Installation would be much the same as the installation of the pipe pile. The H-piling would be driven to the required depth and the single-shaft steel pole would be bolted to a plate attached to the top of the piling.

In competent soils, a single-shaft steel pole could be directly embedded into the soil. In this case, installation techniques would be similar as the installation of a wood pole. The steel pole would be placed into an augured hole and then backfill would be tamped into place.

Structure Assembly and Erection

Towers would be assembled at staging yards along the road or railroad system and flown by helicopter to the sites, or assembled and erected by crane at each site (see Figure B-7). Where tower assembly fly yards are used, they would be placed as conveniently to the line as possible, and spaced for the appropriate flying distance. The optimum distance between assembly yards when using a helicopter to set structures is 5 to 8 miles. However, this distance can be varied somewhat to coincide with existing clearings, such as the airstrips located along the Enstar Route within the KNWR. The size of the assembly yards for helicopter structure staging would be between two and five acres. It is likely that helicopters would be used to set structures on the Kenai Peninsula, except along existing roadways, where cranes would be used. Helicopter setting of structures is also an alternative to mitigate ground disturbance, in the event a structure must be placed in a sensitive area. If cranes are used, there would be some leveling of the immediate tower site required for tower assembly and erection. The area of disturbance for each structure and type of design is as shown in Table B-2. In addition, Figures B-8 through B-16 illustrates structure diagrams. This area of disturbance represents the final tower footprint plus room for maintenance. It does not include a lay down area for tower assembly.

Conductor and OPGW Installation

Stringing the conductors (and OPGW, if specified) would begin after the structures have been erected for several miles to allow for a separation of job duties (see Figure B-7). The first step would be to place the pulling lines in the previously hung stringing blocks (normally part of tower assembly). The pulling line would be used to pull the conductor off the reels and through the stringing blocks. The puller and tensioner would be located at either end of the stringing operation. A typical pulling section would be about 12,000 feet. The puller would pull the wire off the reels and through both the tensioner and stringing blocks, taking up the pulling lines on reels as the wire is installed. The tensioner would control the tension being applied to the wire as it is pulled off the reels by the puller (tension stringing). Temporary guard structures generally of wood pole construction would be erected to prevent the wires from coming in contact with main roads, telephone lines, power lines, and other similar objects, in case of loss of tension in the wire during stringing.

Temporary guying of X-towers or H-frames may be required, and temporary anchors may be installed to hold the stringing equipment and conductors. These temporary guys, anchors, and guard structures would be removed after stringing is completed.

Cleanup of Overhead Facility

Affected areas would be cleaned up as the construction activities progress and are completed. All waste and scrap materials would be removed from the right-of-way and deposited in local permitted landfills in conformance with local ordinance or in accordance with landowner's requests. Ruts and holes resulting from construction activities around structures and along the right-of-way would be repaired. Revegetation and restoration would be conducted as stipulated.

Existing roads, bridges, field roads, and trails would be used for access to the right-of-way and tower sites. Where this is not possible, cross-country travel would be conducted using equipment and methods designed to minimize impacts on vegetation and soils. For example, soft soils may require additional support such as mats or temporary bridges. In rare cases, a temporary culvert may be installed where streams are crossed. Construction trails would be graded and revegetated as necessary to return the land to as close to original condition as practical. Existing roads and trails would be maintained and repaired as required during use by the construction contractor.

TABLE B-2
SUMMARY OF OVERHEAD LINE DESIGN INFORMATION

Line Design *	**1**	**3**	**8**	**9**	**10**	**11**	**13**	**14**	**15**
Project Region	Kenai Lowlands	Kenai Lowlands	Kenai Lowlands	Kenai Lowlands	Kenai Lowlands	Kenai Lowlands	Anchorage Bowl, Kenai Lowlands	Anchorage Bowl	Anchorage Bowl
Structure Type	Guyed X Steel	Guyed X Steel, Heavy	H-frame Wood	Single-shaft Steel Pole, Double Circuit	Single Pole Wood, Single Circuit	Single Pole Wood, Single Circuit, with 12.5kV UB	Single-shaft Steel Pole, Single Circuit	Single-shaft Steel Pole, Single Circuit, with 12.5kV UB	Single-shaft Steel Pole, Single Circuit, with 34.5kV and 12.5kV UB
Drawing Number (See Map Volume)	TANGENT X	LONG SPAN X	TANGENT H	SPOLE-D	SWOOD-1	SWOOD-2	SPOLE-1	SPOLE-2	SPOLE-3
Conductor	795 KCM ACSR	795 KCM ACSR	795 KCM ACSR	795 KCM ACSR	795 KCM ACSR	795 KCM ACSR	795 KCM ACSR	795 KCM ACSR	795 KCM ACSR
Typical Span Length	750 feet	900 feet	750 feet	400 feet	400 feet	300 feet	400 feet	300 feet	300 feet
Typical Structure Height(above ground)	90 feet	95 feet Long Span	90 feet	75 feet	70 feet	70 feet	75 feet	75 feet	75 feet
Ground Clearance	30 feet	30 feet	30 feet	30 feet	30 feet	25 feet	30 feet	25 feet	25 feet
Area of Ground Disturbance	75 feet circle diameter	90 feet circle diameter	70 feet circle diameter	10 feet circle diameter	10 feet circle diameter	10 feet circle diameter	10 feet circle diameter	10 feet circle diameter	10 feet circle diameter
NESC Load Zone	Heavy	Heavy	Heavy	Heavy	Heavy	Heavy	Heavy	Heavy	Heavy
Extreme Wind - Conductor	80 mph	90 mph	80 mph	80 mph	80 mph	80 mph	80 mph	80 mph	80 mph
Extreme Wind - Structure	100 mph	110 mph	100 mph	100 mph	100 mph	100 mph	100 mph	100 mph	100 mph
Extreme Snow (112 kg/cu m [7 lb./cu feet])	6 inches snow, 20 mph wind	6 inches snow, 20 mph wind	6 inches snow, 20 mph wind	6 inches snow, (20 mph) wind	6 inches snow, 20 mph wind	6 inches snow, 20 mph wind	6 inches snow, 20 mph wind	6 inches snow, 20 mph wind	6 inches snow,20 mph wind
Extreme Ice (913 kg/cu m [57 lb./cu feet])	1.5 inches	2 inches; 40 mph wind	1.5 inches	1.5 inches	1.5 inches	1.5 inches	1.5 inches	1.5 inches	1.5 inches
Predominant Foundation Types	Driven Pile	Driven Pile	Direct Embedment	Concrete Pier	Direct Embedment	Direct Embedment	Concrete Pier	Concrete Pier	Concrete Pier

*See Figures B8 – B16 for illustration of line design types and Table B-1 for application by link.
mph = miles per hour km/h = kilometers per hour

Storage and Staging

Construction material storage yards would be located along or near highways, trails, or pipelines in the vicinity of the Project area. The locations of these storage yards are determined by the construction contractor and typically are located approximately every 20 to 30 miles. They are up to 10 acres in size, and probably would be leased property. After construction is completed, all debris and unused materials would be removed and the staging/storage yards would be returned to pre-construction conditions by the construction contractor.

Work Force

It is expected that the proposed transmission line would be constructed under contract by a company specializing in construction of electric transmission lines. As mentioned previously, construction activities are sequential tasks and the number of personnel working at a location depends on the task being performed. Table B-3 lists typical crew sizes and equipment needed for various construction activities.

TABLE B-3
ESTIMATED CONSTRUCTION CREWS AND
EQUIPMENT NEEDS FOR PROJECT CONSTRUCTION

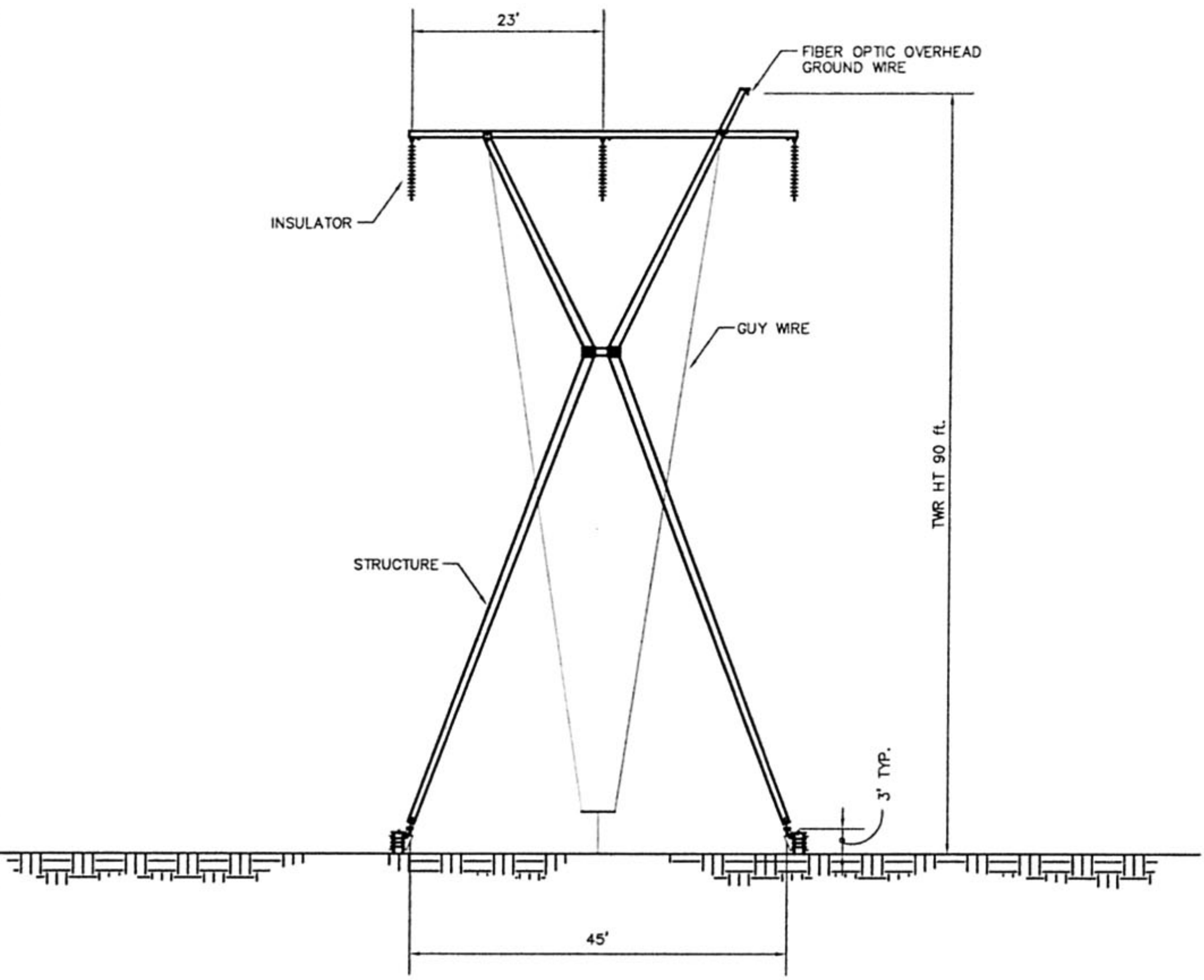
Construction Activity	Crews	Crew Size	Equipment Needed
Soil Boring	1-2	3-4	Rubber-tired or tracked vehicle, or pickup truck
Surveying	2-3	3-4	Pickup truck, all-terrain vehicle (ATV)
Clearing	1-3	3-4	Hydroaxe, chainsaw, pickup truck
Foundation Installation	1-3	3-5	Pile driver, auger, bulldozer, 4-wheel drive, tracked vehicle (NODWELL), air compressor, pickup truck
Structure Assembly	1-3	3-5	Cranes, NODWELL, pickup truck
Structure Erection	1-3	5-6	Cranes, NODWELL, bulldozer, pickup truck
Conductor Installation	3-4	6-8	Reel trailer, tensioner, puller, NODWELL, bucket truck, bulldozer
Cleanup	1-3	2-3	NODWELL, pickup truck

UNDERGROUND FACILITY

Soil Borings and Thermal Resistivity Testing

Soil borings would be taken and tested to determine thermal resistivity of the soils. The boring holes resulting from the tests would be immediately backfilled with the spoil from drilling the holes. As a result of the soil tests, backfill material for the trench following installation would be specified as either trench spoil (the material excavated from the trench), an appropriate selected backfill, or a combination of both select backfill and trench spoil material.

LINE DESIGN 1



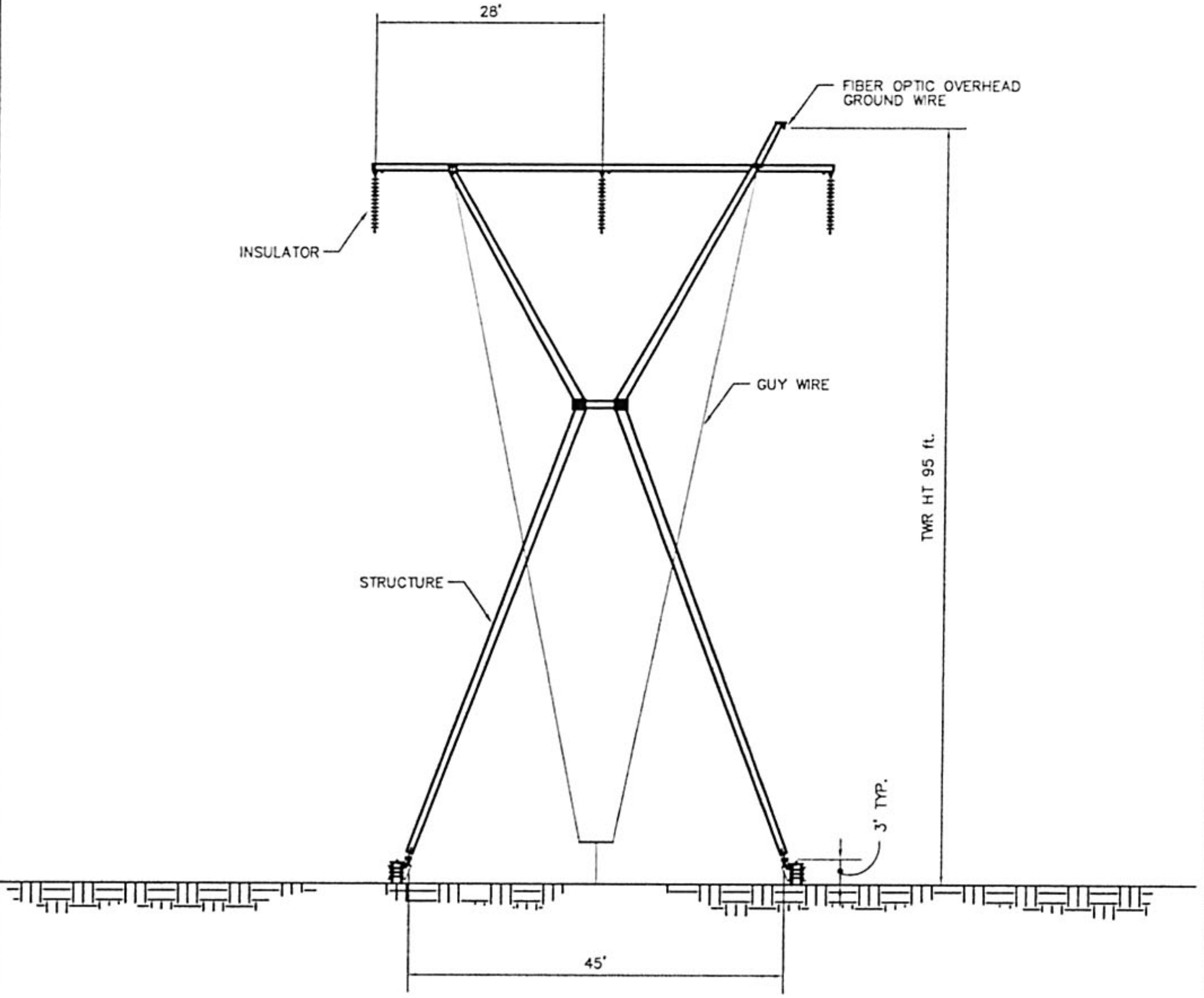
2 FOUNDATIONS AND 2 ANCHORS REQUIRED

* ALL DIMENSIONS ARE APPROXIMATE

FILE NAME: LINEDSGN.DWG REV 2 – 10/98 BY: PEI SCALE: N.T.S.

DRYDEN LARUE, INC. CONSULTING ENGINEERS DATE: 10/01/97 DESIGNED BY: DSL DRAWN BY: RAE	SOUTHERN INTERTIE 230/138 kV TYPICAL TANGENT X-TOWER	DRAWING NO. FIGURE B-8

LINE DESIGN 3



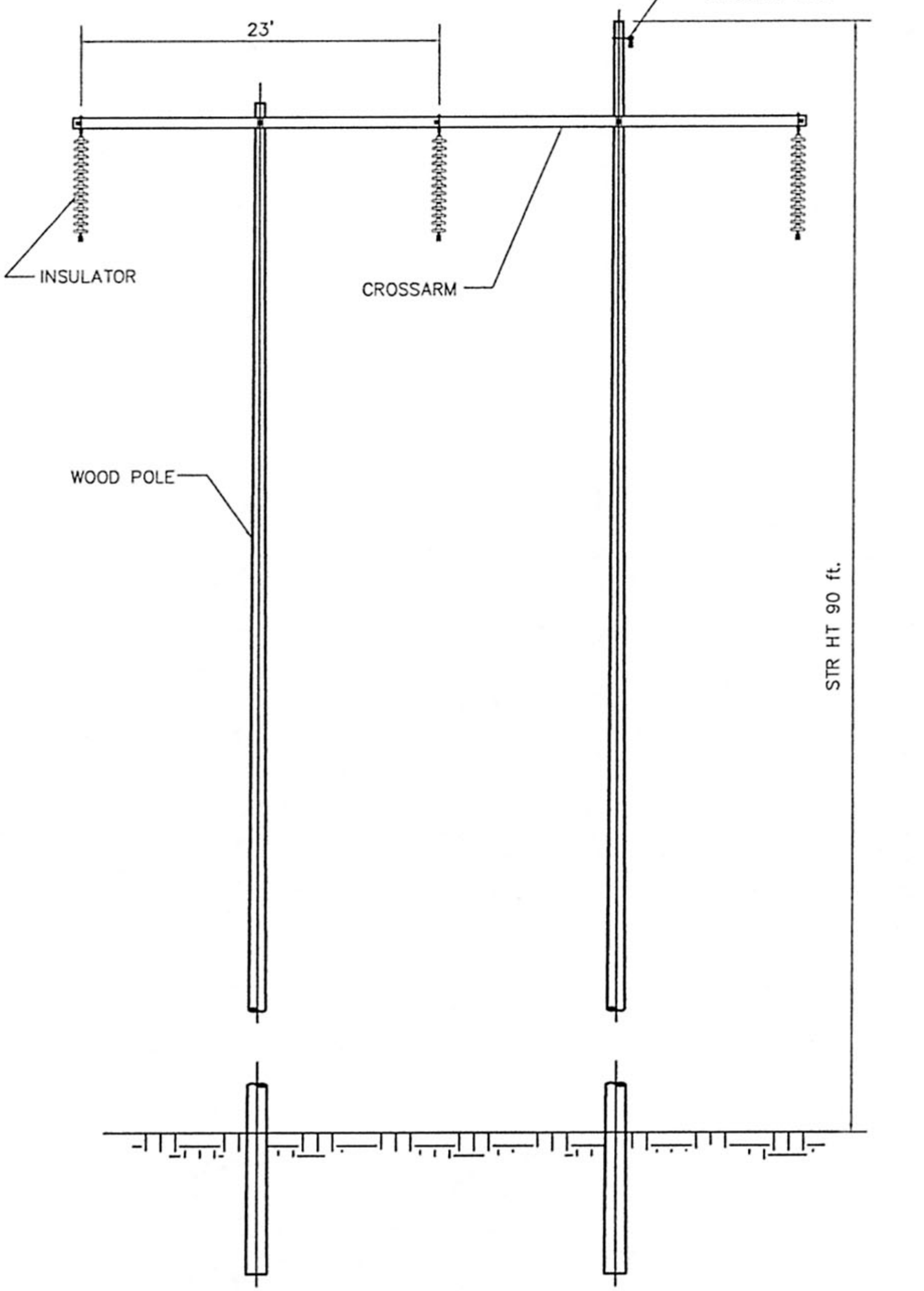
2 FOUNDATIONS AND 2 ANCHORS REQUIRED

* ALL DIMENSIONS ARE APPROXIMATE

FILE NAME: LINEDSGN.DWG REV 2 – 10/98 BY: PEI SCALE: N.T.S.

DRYDEN LARUE, INC. CONSULTING ENGINEERS	SOUTHERN INTERTIE	DRAWING NO.
DATE: 10/01/97 DESIGNED BY: DSL DRAWN BY: RAE	230/138 kV TYPICAL LONG SPAN TANGENT X-TOWER	FIGURE B-9

LINE DESIGN 8



* ALL DIMENSIONS ARE APPROXIMATE

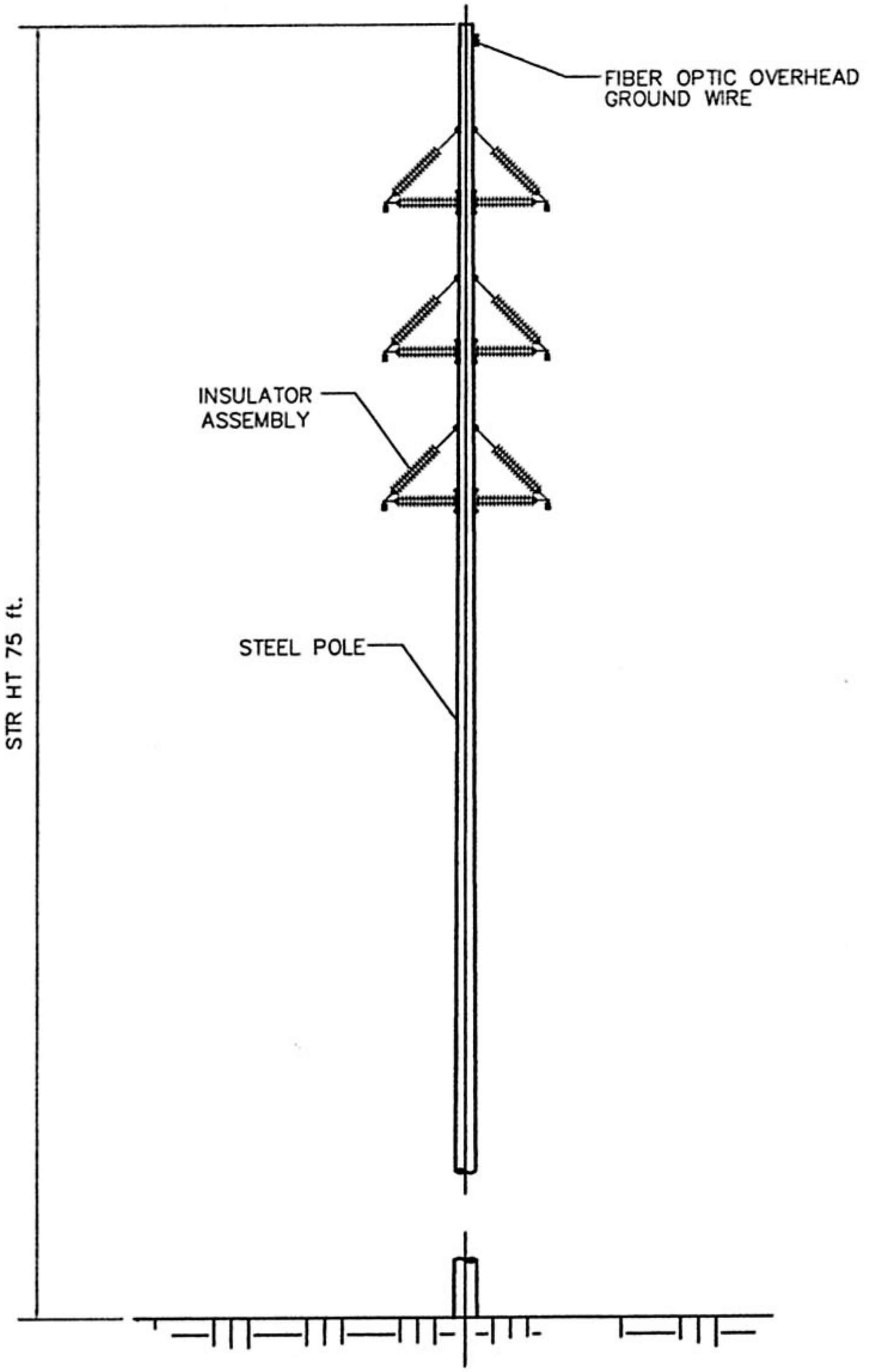
FILE NAME: LINEDSGN.DWG

REV 2 – 10/98 BY: PEI

SCALE: N.T.S.

DRYDEN & LARUE, INC. CONSULTING ENGINEERS DATE: 10/01/97 DESIGNED BY: DSL DRAWN BY: RAE	SOUTHERN INTERTIE 230/138 kV TYPICAL WOOD POLE TANGENT-H	DRAWING NO. **FIGURE B-10**

LINE DESIGN 9



* ALL DIMENSIONS ARE APPROXIMATE

FILE NAME: LINEDSGN.DWG

REV 2 – 10/98 BY: PEI

SCALE: N.T.S.

DRYDEN LARUE, INC.
CONSULTING ENGINEERS

DATE: 10/01/97
DESIGNED BY: DSL
DRAWN BY: RAE

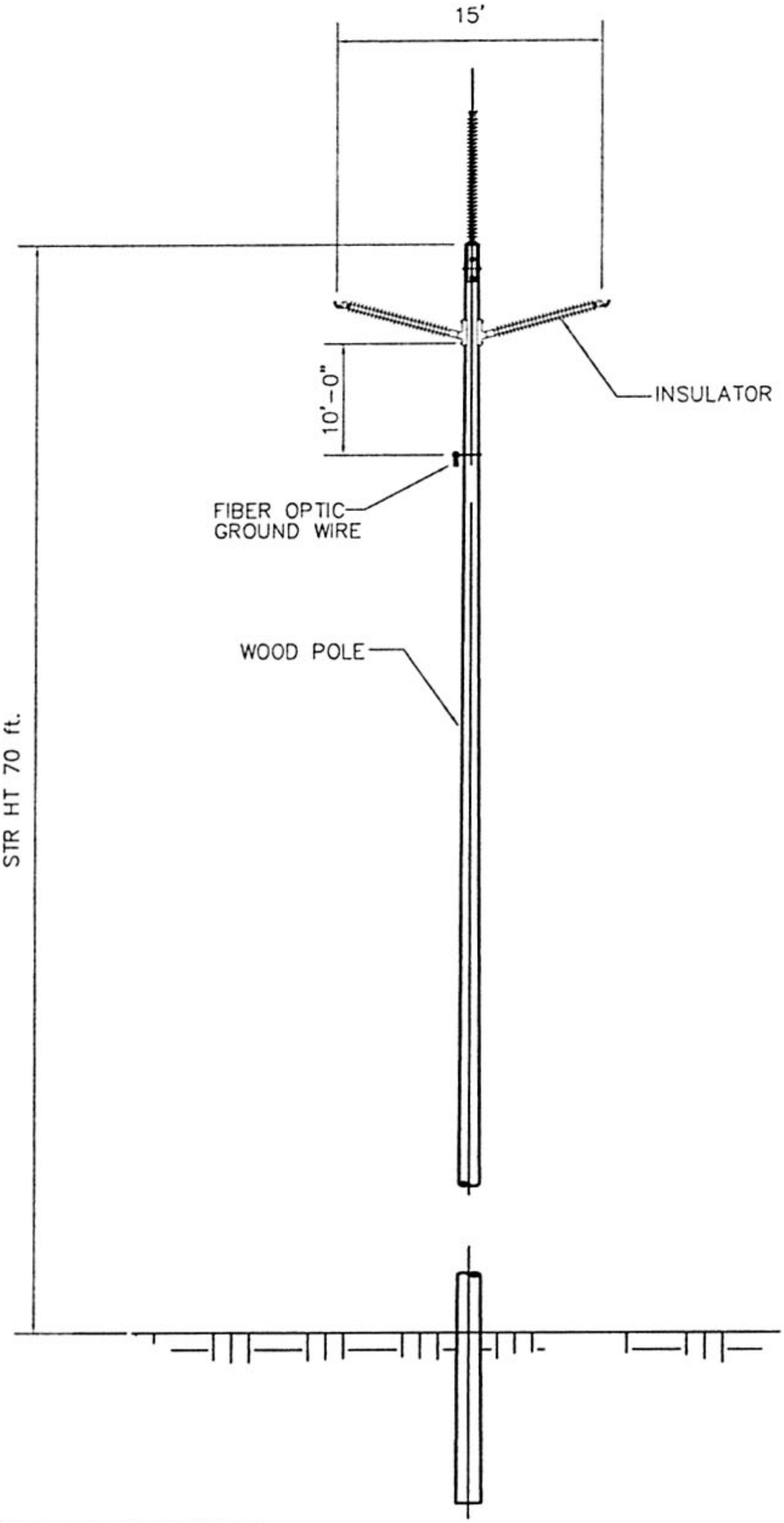
SOUTHERN INTERTIE

230/138 kV DOUBLE CIRCUIT
SINGLE-SHAFT STEEL POLE TANGENT

DRAWING NO.

FIGURE B-11

LINE DESIGN 10



* ALL DIMENSIONS ARE APPROXIMATE

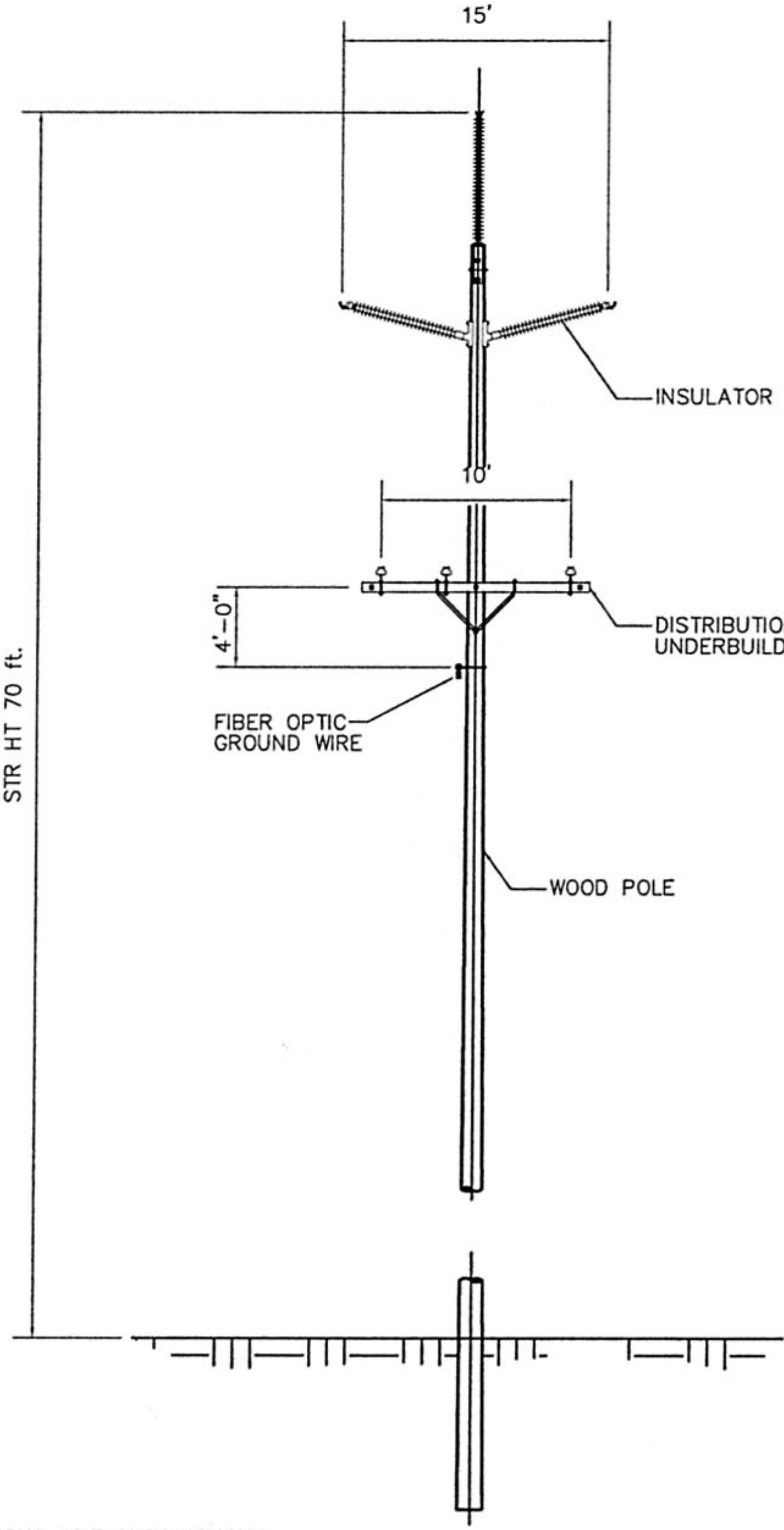
FILE NAME: LINEDSGN.DWG

REV 2 – 10/98 BY: PEI

SCALE: N.T.S.

DRYDEN LARUE, INC. CONSULTING ENGINEERS DATE: 10/01/97 DESIGNED BY: DSL DRAWN BY: RAE	SOUTHERN INTERTIE 230/138 kV SINGLE WOOD POLE TANGENT	DRAWING NO. FIGURE B-12

LINE DESIGN 11



* ALL DIMENSIONS ARE APPROXIMATE

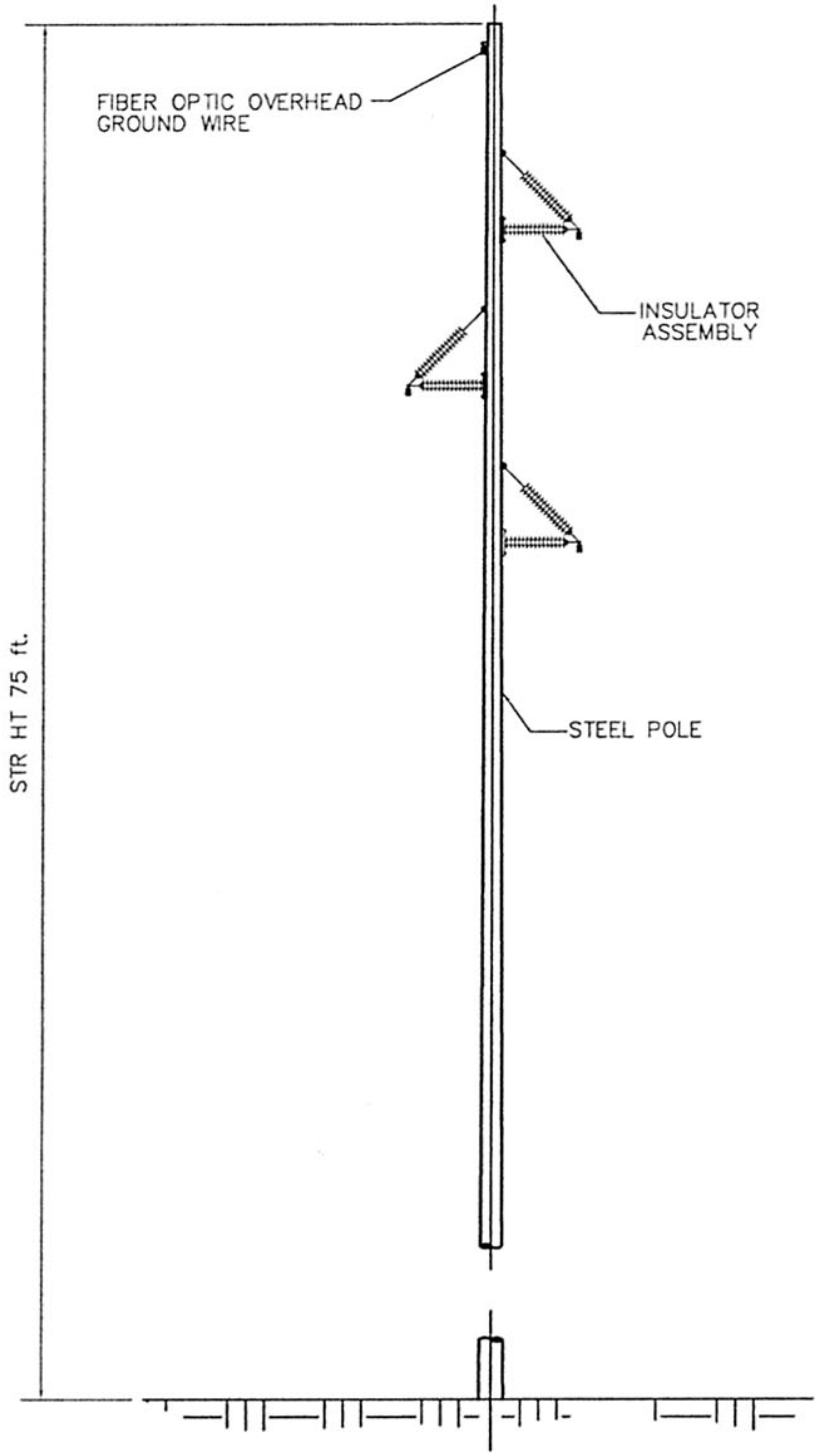
FILE NAME: LINEDSGN.DWG

REV 2 – 10/98 BY: PEI

SCALE: N.T.S.

DRYDEN LARUE, INC. CONSULTING ENGINEERS DATE: 10/01/97 DESIGNED BY: DSL DRAWN BY: RAE	SOUTHERN INTERTIE 230/138 kV WITH UNDERBUILD SINGLE WOOD POLE TANGENT	DRAWING NO. FIGURE B-13

LINE DESIGN 13

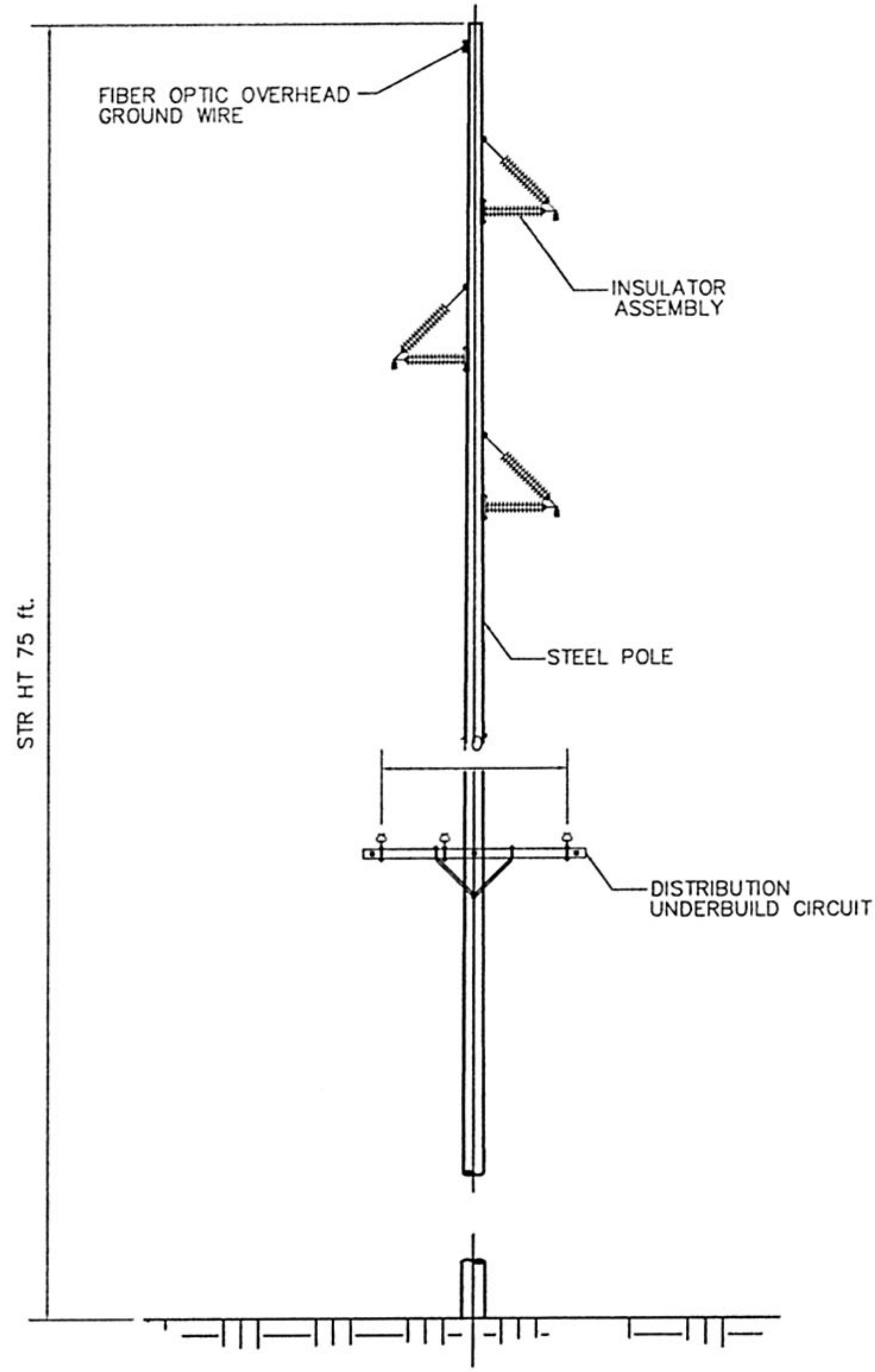


* ALL DIMENSIONS ARE APPROXIMATE

FILE NAME: LINEDSGN.DWG   REV 2 – 10/98   BY: PEI   SCALE: N.T.S.

DRYDEN LARUE, INC. CONSULTING ENGINEERS DATE: 10/01/97 DESIGNED BY: DSL DRAWN BY: RAE	SOUTHERN INTERTIE 230/138 kV SINGLE-SHAFT STEEL POLE TANGENT	DRAWING NO. FIGURE B-14

LINE DESIGN 14



* ALL DIMENSIONS ARE APPROXIMATE

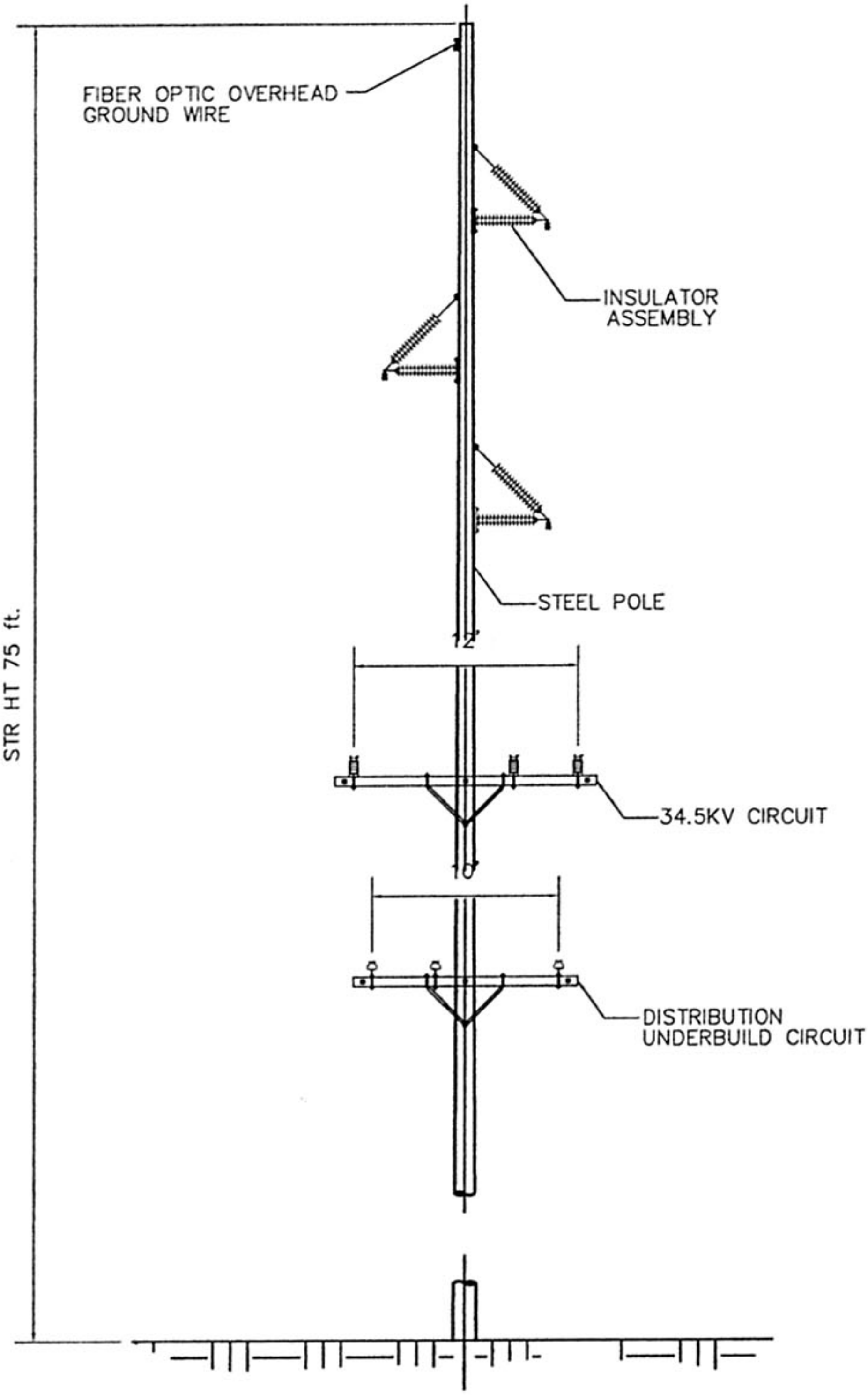
FILE NAME: LINEDSGN.DWG

REV 2 – 10/98 BY: PEI

SCALE: N.T.S.

DRYDEN LARUE, INC. CONSULTING ENGINEERS DATE: 10/01/97 DESIGNED BY: DSL DRAWN BY: RAE	SOUTHERN INTERTIE 230/138 kV WITH UNDERBUILD SINGLE-SHAFT STEEL POLE TANGENT	DRAWING NO. FIGURE B-15

LINE DESIGN 15



* ALL DIMENSIONS ARE APPROXIMATE

FILE NAME: LINEDSGN.DWG | REV 2 – 10/98 | BY: PEI | SCALE: N.T.S.

DRYDEN LARUE, INC.
CONSULTING ENGINEERS

DATE: 10/01/97
DESIGNED BY: DSL
DRAWN BY: RAE

SOUTHERN INTERTIE

230/138 kV WITH 34.5 kV AND UNDERBUILD
SINGLE-SHAFT STEEL POLE TANGENT

DRAWING NO.

FIGURE B-16

Surveying

Surveying would be accomplished by ground survey methods. Survey work on the right-of-way may involve limited trimming of trees and vegetation for line-of-sight staking and distance measuring. Section and quarter-section corners would be located to register survey to pre-established coordinates and boundaries. The edge of the right-of-way would be staked in areas where construction clearing is required.

Clearing

Clearing would be performed as required to allow for access and construction of the underground line and to maintain access for operation and maintenance of the underground system. Trees on the right-of-way would be cut as close to the ground as possible to allow equipment access. Clearing material would be disposed in compliance with local ordinances and in accordance with landowner requests and agreements.

Site Preparation

During construction, manhole locations require room to access the site for cable pulling and splicing activities. Transition station locations have these same requirements. The operation and maintenance access for the underground cable requires site access roads to the transition sites, riser poles, and manholes. There would be some clearing of access roads and trails, and the leveling of work sites for these activities, which would be accessed by existing public roads to the extent possible. The Anchorage area allows the majority of the underground transition locations to be accessed by public roads.

Underground Duct Bank System Installation

Trenching

Trenching operations for installation of an underground duct bank raceway system would involve similar procedures for the two types of underground duct bank proposed. Either a conventional concrete-encased duct bank or a duct bank casing pipe raceway system could be used, depending on location.

Trenching operations would be staged in intervals, with a typical construction sequence having a duration of three to five days per 300 to 500 feet for concrete encased duct bank, and a duration of three to five days per 800 to 1,000 feet of casing pipe duct bank installation. A typical trench would be 3.5 to 4 feet-wide with a depth of 5 feet. The amount of trench open at any one time would be limited to the length required to facilitate the duct bank installation process.

In general, underground crossings of roads and railroads would be bored as described below. However, some locations along the proposed routes may require pavement cutting. These locations may include some roadways, driveways, parking lots, and access roads. At these locations, installation work would require ground breaking of the surface layer materials. In the event the route is in line with paved areas, pavement and subsurface material would be removed from the site and disposed of at an appropriate location according to local regulations and guidelines.

Trench spoil would be stockpiled alongside the open trench. Topsoil will be segregated from other soil and replaced separately to promote revegetation. Trench sheeting and shoring would be installed to maintain trench walls in trench segments that are deeper than 5 feet and in segments that exhibit unstable soils. Where necessary, temporary fence and traffic control barriers would be used to restrict public access. Traffic would be maintained in areas requiring vehicular traffic crossing of the open trench with steel plating and trench bridging as required.

After installation of the duct bank, the ground surface would be restored. Cleared areas would be revegetated in a manner consistent with the surrounding area. Areas involving pavement cutting would be restored by compacting the soil and repaving in conformance with applicable specifications.

Underground Concrete-Encased Duct Bank

The 138kV hearing, ventilating, and air conditioning cross linked polyethylene underground transmission system would be installed with 4-inch to 6-inch polyvinyl chloride (PVC) conduits in a flat horizontal configuration duct bank encased in concrete. The conduits would be assembled into place in the trench using “chairs” or “spacers” to keep them off the trench bottom and away from the trench sides. Concrete would be poured to completely encase the conduits with a minimum of 3 inches of concrete around the conduits. After the concrete sets up for a 24-hour period, backfilling and compaction may be completed above the duct bank. The equipment required for this installation is listed later in this section.

The concrete-encased duct bank installation would prove useful in areas close to public access roads such as North Kenai Road and in Captain Cook SRA in the Kenai Lowlands region. The concrete-encased duct bank installation would be the proposed method of installation in the Anchorage area regions.

Underground Duct Bank Casing Pipe

Areas involving installation challenges due to limited access, environmental conditions, and limited construction season would involve the use of a duct bank casing pipe. The installation of this duct bank raceway type would be very similar to the installation of a single pipeline. The high-voltage cable conduit would be installed in a 24- to 30-inch polyethylene or steel pipe. The pipe section would be laid along the ground next to an open trench before installation and the pipe would be laid out along the right-of-way and installed and backfilled simultaneously. After placement in the trench, a concrete slurry would be pumped in the casing pipe at the fill tube locations to fill the casing annulus. Fill tubes would be cut off below grade and sealed. The same duct bank casing arrangement would be used for road and railroad crossings that are not conducive to open cut trenching. However, in those crossings a steel casing would be used. The casing would be installed by a jack and bore method. This technique involves pushing a casing under a road or railroad for crossing distances from 100 to 400 feet in length.

In these instances, a launching pit would be installed on one side of the crossing and a receiving pit would be located in line on the other side of the crossing. A jack and bore machine would be anchored in the launching pit. An auger would be installed inside the casing pipe to return the tailings. The ram of the jack and bore machine would push the casing pipe horizontally under the crossing while the auger simultaneously excavates the leading end spoil materials. Each section of pipe would be subsequently welded to the end of the last pipe section pushed into the bore hole until the crossing is completed, with the first pipe section daylighting into the receiving pit.

Cleanup

Affected areas would be cleaned up as the construction activities progress and are completed. All waste and scrap materials would be removed from the right-of-way and deposited in local permitted landfills in conformance with local ordinance or in accordance with landowners' agreements. Ruts and holes resulting from construction activities around structures and along the right-of-way would be repaired. Revegetation and restoration would be conducted as required.

Storage and Staging Yards

Construction material storage yards may be located along or near highways, trails, or pipelines in the vicinity of the Project area. The locations of these storage yards are determined by the construction contractor and typically are located as often as required for efficient operation. They are up to two acres in size, and probably would be leased property. After construction is completed, all debris and unused materials would be removed and the staging/storage yards would be returned to pre-construction conditions by the construction contractor. Trench spoil would be stockpiled alongside the open trench in all areas where trenching is required for duct bank installation.

Expected Equipment

Construction of the underground portion of a transmission line project requires much of the same equipment required for overhead line construction. During the duct bank, transition site, and riser pole installations, right-of-way access is required. As with other construction projects the contractor methods of approaching the construction may vary. Tables B-4 and B-5 list equipment that would most probably be used for construction, operation, and maintenance access.

TABLE B-4 UNDERGROUND CONSTRUCTION		
Construction Types	**Access**	**Construction Equipment**
1	Existing roadways	Rubber-tired vehicles
1, 2	Existing trails	NODWELL
3	Soft, difficult trails	Special sized equipment, low bearing pressure
1, 5	Stream crossing	Rubber-tired vehicles special equipment-bridge

TABLE B-5 EQUIPMENT NEEDED FOR UNDERGROUND CONSTRUCTION PROCESS				
Construction Types	**Access**	**Crews**	**Crew Size**	**Equipment Needed**
1, 2, 3	Soil boring/ geotechnical	1-2	3-4	Rubber-tire-tracked vehicle, pickup truck
1, 2	Survey	2-3	3-4	Pickup truck, ATV
1, 2, 3	Clearing	3-4	2-3	Hydroaxe, chain saws, brush hog, bulldozer, pickup truck
1, 2, 3, 4	Riser pole installation	1-3	3-4	Auger, bulldozer, NODWELL, air compressor, generator, pickup truck, crane or helicopter
1, 2, 3	Duct bank installation	1-3	6-8	D-7 CAT, 200 Hitachi or 100 Komatsu excavators (long carriage/wide track, if required)
1, 2, 3,	Cable pulling	3	1-2 man, 1-3 man, 1-7 man	Reel strands, cable, arbors, bullwheel, pulling winch, arnco or mousing winch, crane 100-ton, tractor with low boy trailer, or helicopter dynamometer, generator compressor, water pump
1, 2, 3	Splicing of underground cable	2	2-3	Rubber-tired vehicles, pickup trucks, generators, splice container, 25-ton crane, tractor with lowboy
1, 2, 3	Termination of underground cable	3	2-3	Bucket trucks or scaffold, 15-ton crane, tarping, generators, pickup trucks
1, 2, 3	Cleanup and demobilize	1-3	2-3	Pickup trucks, dump trucks, NODWELL, loader

Expected Construction Methods by Link

Contractors use similar methods for underground transmission line construction, but each contractor may approach each project in a different manner. However, each contractor would be required to work within the requirements of the Project agreement between the owner and landowners. The types of construction activities that would take place on each link are listed in Table B-6.

Link	Miles Crossed	Existing Right-of-Way Use Paralleled	Adjacent Uses	Right-of-Way or Easement Width (feet)	Access To Area: Existing	Access To Area: Proposed Construction	Activities	Construction Timing (season)	Construction Method	Operation and Maintenance
Anchorage Bowl										
A11	0.3	Railroad	Coastal Wildlife Refuge	30	Railroad right-of-way	Underground***	Trenching***	Submarine	3, 5 and 7	3 and 5
A11	0.7	Railroad	Shooting Range	30	Railroad right-of-way	Underground cable*	Duct Bank Type 1, Cable Installation	Summer	1	1
A6	0.4	Railroad	Residential / Flying Crown airstrip	30	Railroad right-of-way	Submarine cable*	Trenching***	Submarine	1	1
A6	0.5	Railroad	Residential / Flying Crown airstrip	30	Railroad right-of-way	Underground cable*	Duct Bank Type 2, Cable Installation	Summer	1	1
A2	0.7	Roadway	Klatt Road	30	Paved road	Submarine cable*	Trenching***	Submarine	1	1
T18	0.4	Pipeline	Kincaid Park	30	None	Underground cable*	Duct Bank Type 1, Cable Installation	Summer	3	3
T18	1.7	Pipeline	Kincaid Park/airport	30	None	Underground cable*	Duct Bank Type 1, Cable Installation	Summer	3	3
T18	1.9	Future airport development	Airport	30	None	Underground cable*	Duct Bank Type 1, Cable Installation	Summer	3	3
Turnagain Arm										
T10	9.2	---	---	150	---	Submarine cable	Direct Lay	Submarine	3, 5 and 7	3 and 5
T14	5.0	---	---	150	---	Submarine cable	Embed & Trenching	Submarine	3, 5 and 7	3 and 5
T16	3.8	Pipeline	---	150	---	Submarine cable	Direct Lay	Submarine	3, 5 and 7	3 and 5
T17	10.1	Pipeline	Coastal Wildlife Refuge	150	---	Submarine cable	Direct Lay, Embed and Trenching	Submarine	3, 5 and 7	3 and 5
T15	17.2	---	---	150	---	Submarine cable	Direct Lay, Embed and Trenching	Submarine	3, 5 and 7	3 and 5
A1	0.3	---	Victor Road	30	---	Submarine cable	Trenching***	Submarine	1	1
E11	11.2	---	Coastal Wildlife Refuge	150	---	Submarine cable	Embed, Trenching and HDD	Submarine	3, 5, 6 and 7	3 and 5
E13	9.0	---	Coastal Wildlife Refuge	150	---	Submarine cable	Embed, Trenching and HDD	Submarine	3, 5, 6 and 7	3 and 5
E12	10.5	---	Coastal Wildlife Refuge	150	---	Submarine cable	Embed, Trenching and HDD	Submarine	3, 5, 6 and 7	3 and 5
Kenai Lowland										
T3	0.9	Roadway	Commercial/residential/two airstrips	30	Paved road	Underground Cable**	Duct Bank Type 1, Cable Installation	Summer	1	1
T5	3.4	Roadway	Captain Cook SRA	30	Paved road	Underground cable	Duct Bank Type 1, Cable Installation	Summer	1 or 2	1 or 2
T5	0.6	Two pipelines	Captain Cook SRA	30	FWD road	Underground cable	Duct Bank Type 1, Cable Installation	Summer	1 or 2	1 or 2
T13	0.4	FWD road	CIRI - airstrip	30	FWD road	Underground***	Trenching***	Submarine	1, 2, 3, 5	1, 2 and 5
T8	0.4	Pipeline	Private/State Land	30	FWD trail	Submarine cable*	Trenching***	Submarine	2 or 3	2 or 3
T9	1.0	Pipeline	Kenai National Wildlife Refuge	30	FWD trail	Submarine cable*	Trenching***	Submarine	2 or 3	2 or 3

CIRI – Cook Inlet Region, Inc. FWD - four-wheel drive HDD - horizontal directional drill SRA - State Recreation Area

Construction Timing:
Winter Season – Frozen: November to March
Summer Season – Thawed: April to October
Submarine Cable – May to June is preferred

Construction and Operation and Maintenance Methods:
1 – Rubber-tired vehicle: Pickup trucks, bucket trucks, loaders, backhoe, trenchers
2 – Tracked Vehicle: NODWELL, bulldozers, backhoe
3 – Special Equipment: Swamp Buggy, low ground pressure vehicles
4 – Aerial: Helicopter, fixed-wing aircraft
5 – Submarine: Cable barge and special equipment
6 – Horizontal Directional Drilling Casing: HDD drill rig
7 – Specialized Submarine Embedment: Special submarine water-jet type or marine floor trenching

* Mitigation
** Two airstrips in this link. Underground across the end of runways assumed as mitigation. To be discussed with airstrip owners for final configuration. Balance of link is overhead.
*** Underground construction techniques would be used to direct bury submarine cable on land without the armor normally used for marine conditions.

Work Force Size

The underground portions of the proposed transmission line would be constructed under contract by a qualified company with experience in the installation of high-voltage underground systems.

Time and other factors such as season and terrain would affect the number and sizes of crews. The contractor selected for construction would determine the size of the work force. It is anticipated that personnel for the work force would be hired locally and others imported from other areas.

SUBMARINE CABLE

Table B-7 identifies equipment that would be required to complete the installation activities. Figures B-17 through B-25 illustrate submarine cable laying options.

Final Survey and Site Preparation

Final Survey

A final survey would be based on a preliminary survey taken during the detailed design phase of the Project that would identify certain objectives such as local conditions and confirm the survey areas in detail. The following are features to be identified:

- landing locations for cable
- contour and profile of seabed
- support facilities
- cable routes
- obstruction and hazards in the vicinity
- access to landing points from land
- station site selection for the navigation system used in the survey and installation

The perimeter of the final survey would include an area wide enough to accommodate a cable spacing adequate to allow the repair of a cable without the risk of damaging adjacent cables. A sub-bottom seismic investigation and core sampling would be undertaken at frequent locations to allow for an accurate interpretation of the seismic recordings. A side scan and bottom scan sonar survey also may be required to locate seabed features that may influence the trench cutting and cable burying machinery.

A water current survey would be performed where the cable would be laid directly on the bottom. An accurate bathymetric survey to identify exposed rock, wrecks, and other hazards would help in the final location and placement of the cable.

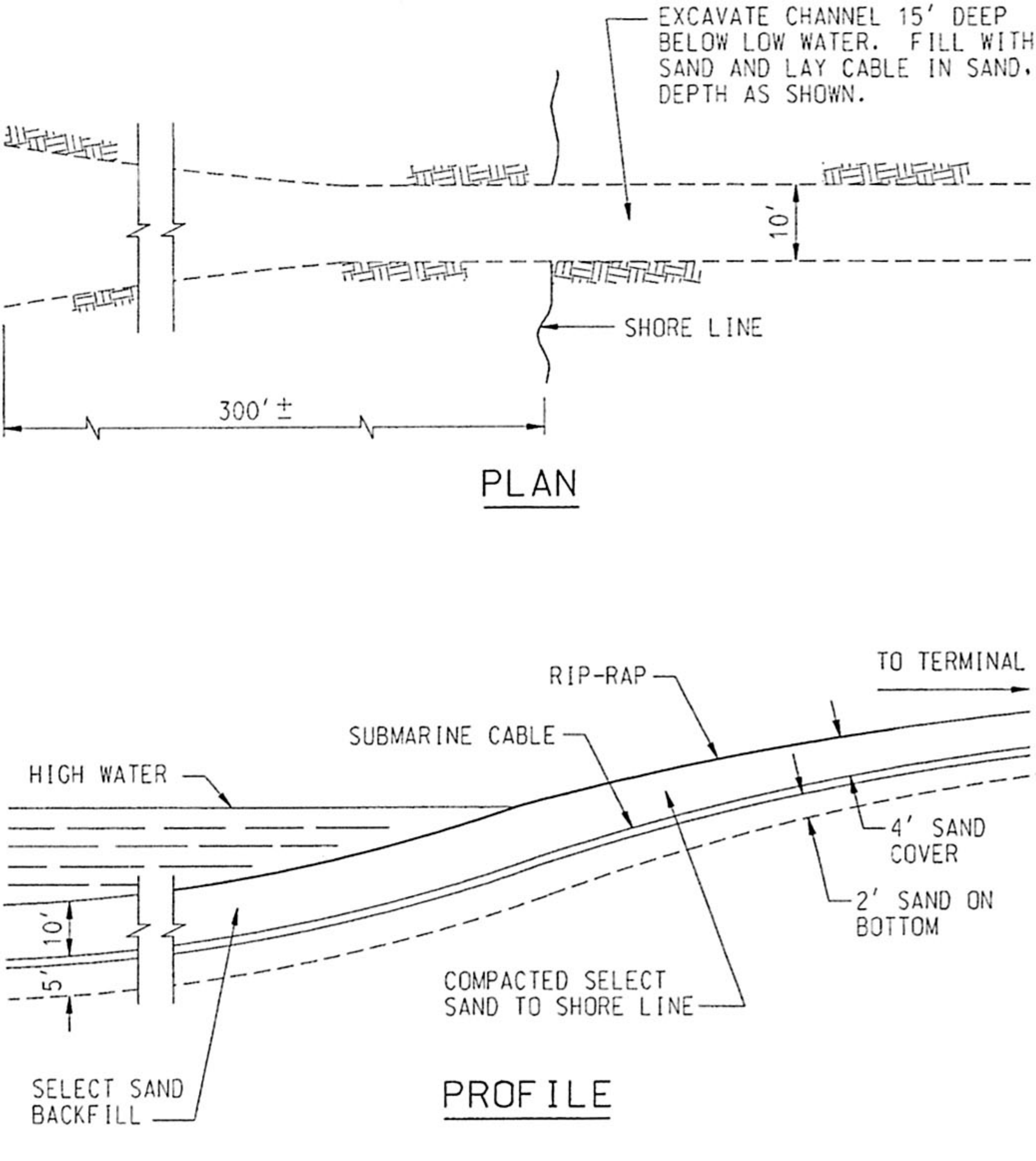
TABLE B-7
SUBMARINE CABLE INSTALLATION EQUIPMENT

Const. # Types*	Access	Installation Technique	Crews	Crew Size	Equipment Needed
1	Final survey Site preparation	Navigation Barge Land clearing	1	3-4	Marine survey equipment Small barge for setting marker buoys, setting anchors and trial mooring Front loaders for clearing of cable landing areas
7	Deep channel Direct laying	Anchor pull line Free boat tow	1-2	5-6	Cable barge+ Tug boat Submarine Cable guide boats
1, 2, 3, 5, 6 & 7*	Tidal mud flats Shore trail installation	Conventional trenching	1-2	3-4	D-7 CAT 200 Hitachi or 100 Komatsu excavators
		Horizontal directional drill (HDD)	1-2	5-6	Horizontal Direction Drill (HDD) Drill Rig #
		Embedment Simultaneous & After Laying	1-2	5-6	
		A. Hydraulic jetting	1-2	5-6	A. Cable barge+ Special submarine water jet type burying machine
		B. Marine floor trenching	1-2	5-6	B. Cable barge+ Special submarine marine floor trenching machine

+ Typical cable barge equipment:
- cable coiling equipment
- cable brake equipment
- cable skid and rollers
- generators
- winches
- radio communication system
- navigation equipment
- cable floats
- crane

Typical HDD rig and support equipment:
- HDD hydraulic-powered drill rig
- hydraulic crane
- fresh water tank
- bentonite and water mix tank
- generator
- mud motor and pumping facilities
- drill head control cab trailer
- computerized guidance system
- drillers mud and re-circulating and screening equipment
- radio communication system
- utility trailer

* Construction types are defined in Table B-6.



TRENCHED SHORE END SUBMARINE CABLE LANDING

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CKD	BH	9/97
SCALE:	NTS	

POWER ENGINEERS
3940 GLENBROOK DRIVE
HAILEY, IDAHO 83333

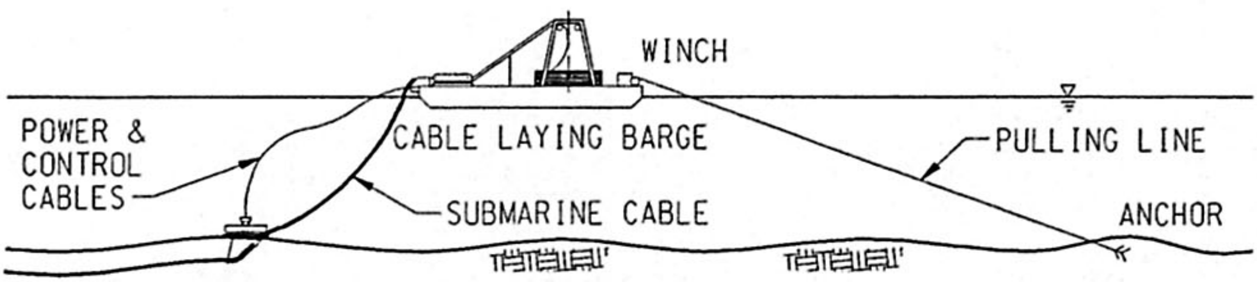
SOUTHERN INTERTIE PROJECT

TRENCHED SHORE END SUBMARINE CABLE INSTALLATION

JOB NUMBER 120376

DRAWING NO. Figure B-17 | REV A

$$$$SYTIME$$$$$$ hofsz.tbl subed2.dgn



PROFILE

INSTALLATION BY SIMULTANEOUS LAYING AND BURYING USING SPECIAL WATER-JET TYPE MACHINE OR MARINE FLOOR TRENCHING MACHINE

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DRN	DWN	9/97
CKD	BH	9/97

SCALE: NTS

POWER ENGINEERS
3940 GLENBROOK DRIVE
HAILEY, IDAHO 83333

SOUTHERN INTERTIE PROJECT

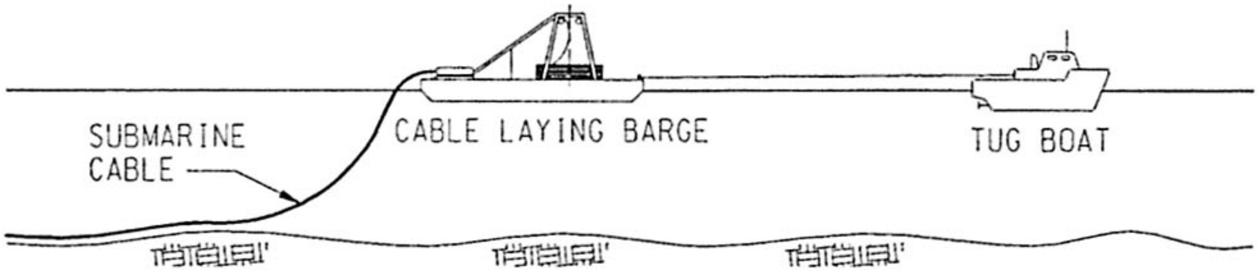
DIRECT EMBEDMENT
OF SUBMARINE CABLE

JOB NUMBER
120376

DRAWING NO. Figure B-18

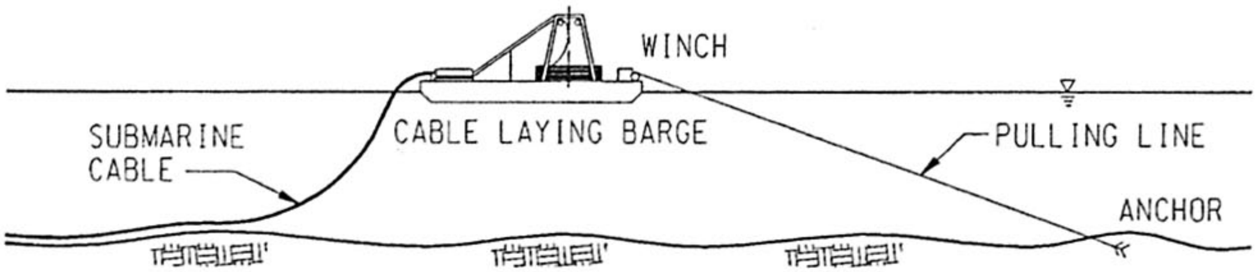
REV A

$$$$$YTIME$$$$$$$



PROFILE

FREE BOAT
DIRECT LAYING



PROFILE

ANCHOR PULL LINE
DIRECT LAYING

DSGN	BH	9/97
DRN	DWN	9/97
CKD	BH	9/97
SCALE:	NTS	

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3940 GLENBROOK DRIVE
HAILEY, IDAHO 83333

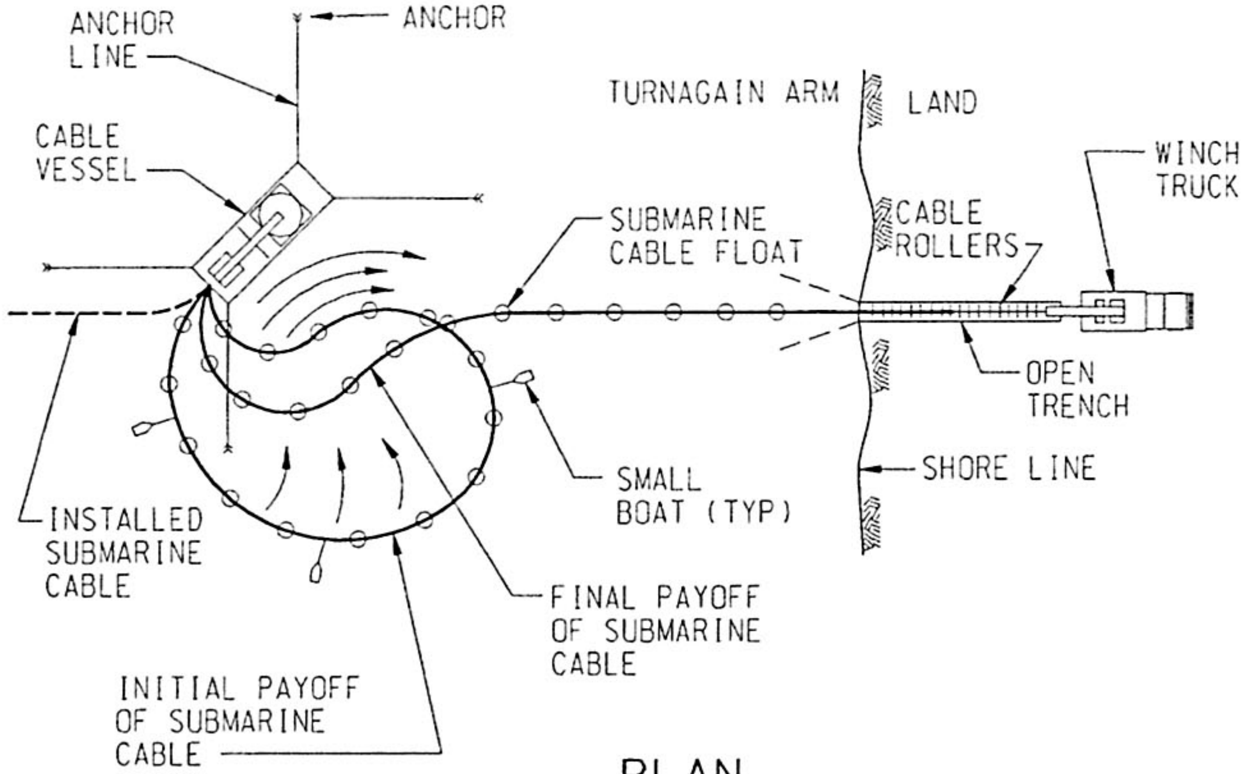
SOUTHERN INTERTIE PROJECT

DIRECT LAY
SUBMARINE CABLE INSTALLATION

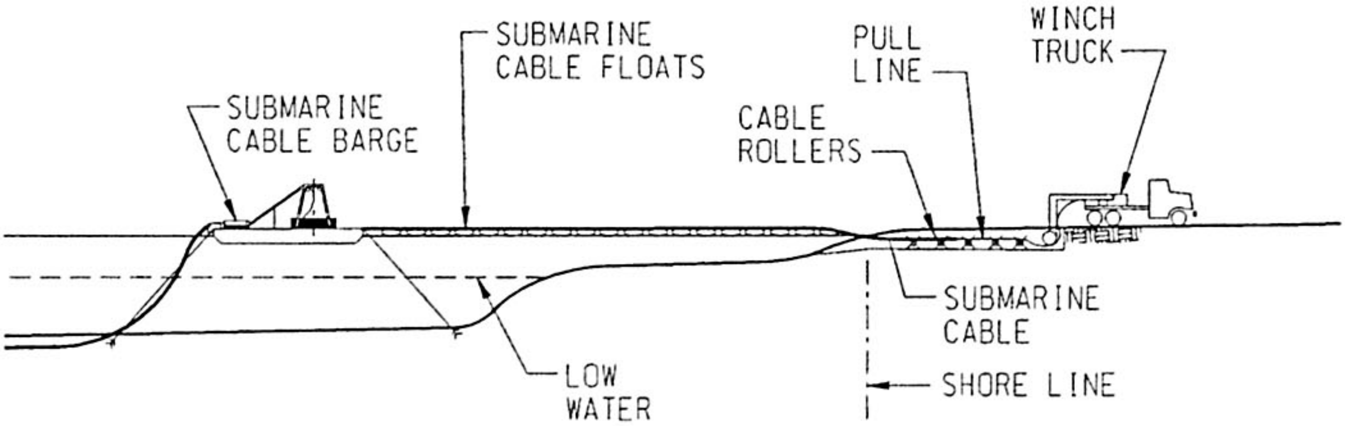
JOB NUMBER
120376

DRAWING NO. REV
Figure B-19 A

$$$$SYTIME$$$$$$$ hdfe2.tbl subm07.dgn



PLAN



PROFILE

SHORE END SUBMARINE CABLE LANDING

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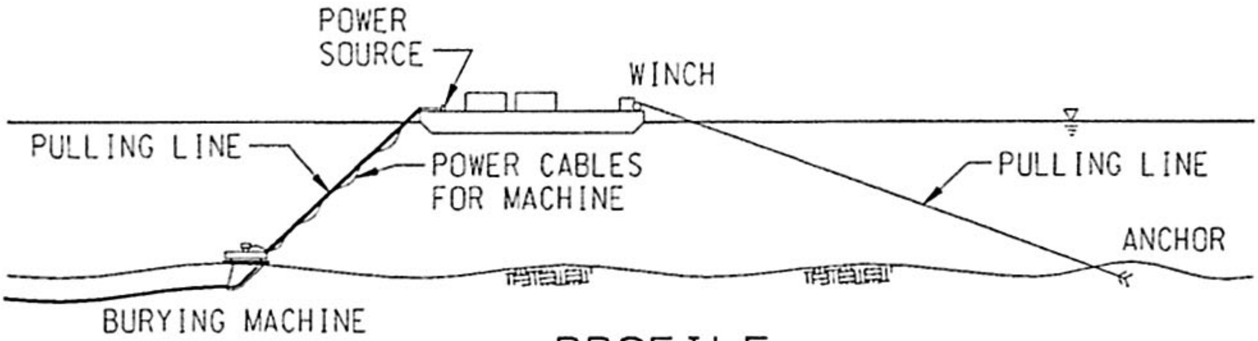
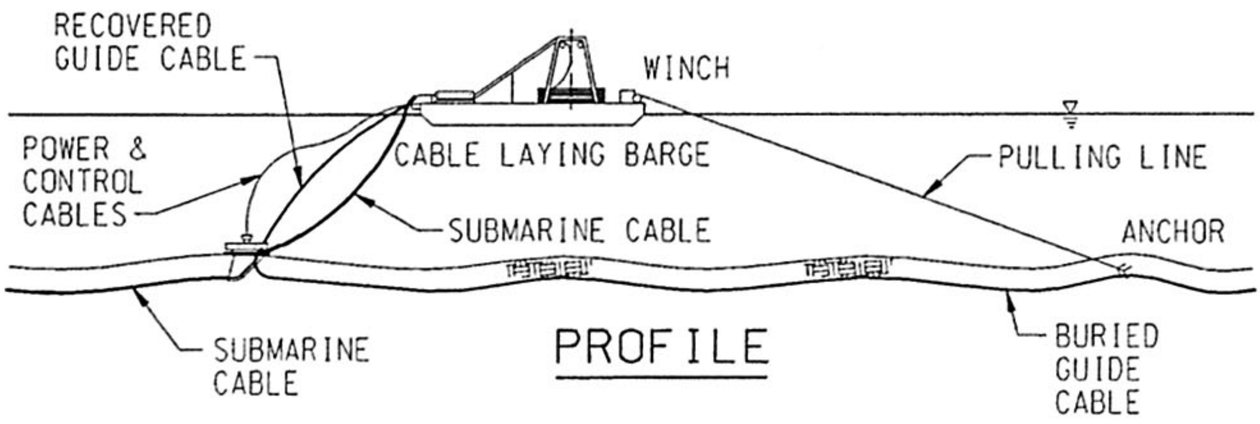
$$$$SYTIME$$$$$$ hdfsz.tbl subm01.dgn



PROFILE

INSTALLATION OF GUIDE LINE



PROFILE

AFTER LAY EMBEDMENT OF SUBMARINE CABLE

DSGN	BH	9/97
DRN	DWN	9/97
CKD	BH	9/97
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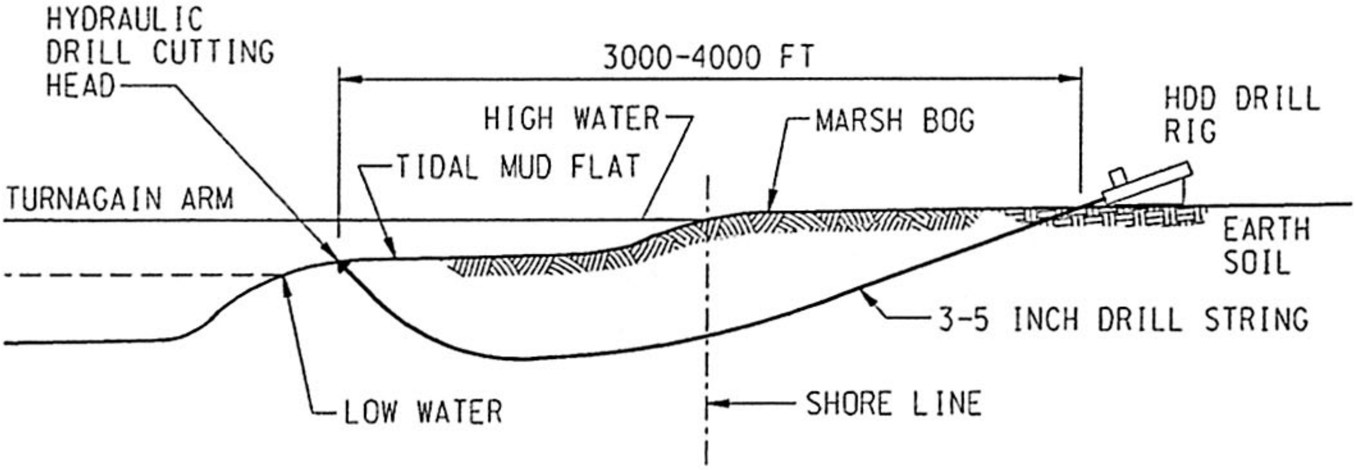
SOUTHERN INTERTIE PROJECT

DIRECT EMBEDMENT WITH GUIDE LINE
SUBMARINE CABLE INSTALLATION

JOB NUMBER 120376

DRAWING NO. Figure B-21

REV A



PROFILE

STEP 1: INSTALLATION OF DRILL STRING PROFILE

DSGN	BH	9/97
DRN	DWN	9/97
CKD	BH	9/97
SCALE:	NTS	

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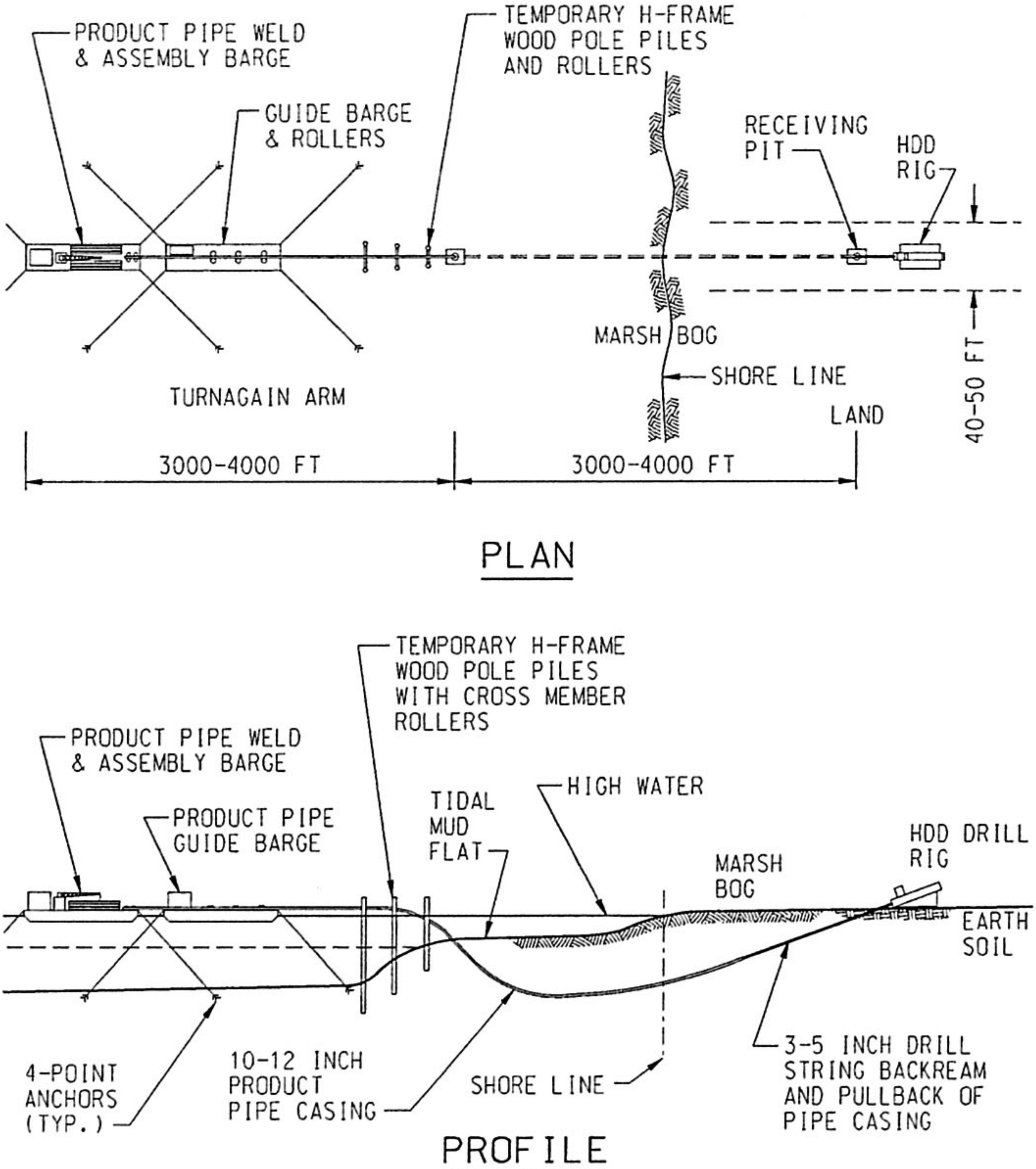
HDD PILOT HOLE INSTALLATION

JOB NUMBER 120376

DRAWING NO. Figure B-22

REV A

$$$$SYTIME$$$$$$$$ hdfaz.tbl subm03.dgn



STEP 2: PULLBACK INSTALLATION OF PRODUCT PIPE CASING PROFILE

DSGN	BH	9/97
DRN	DWN	9/97
CKD	BH	9/97

SCALE: NTS

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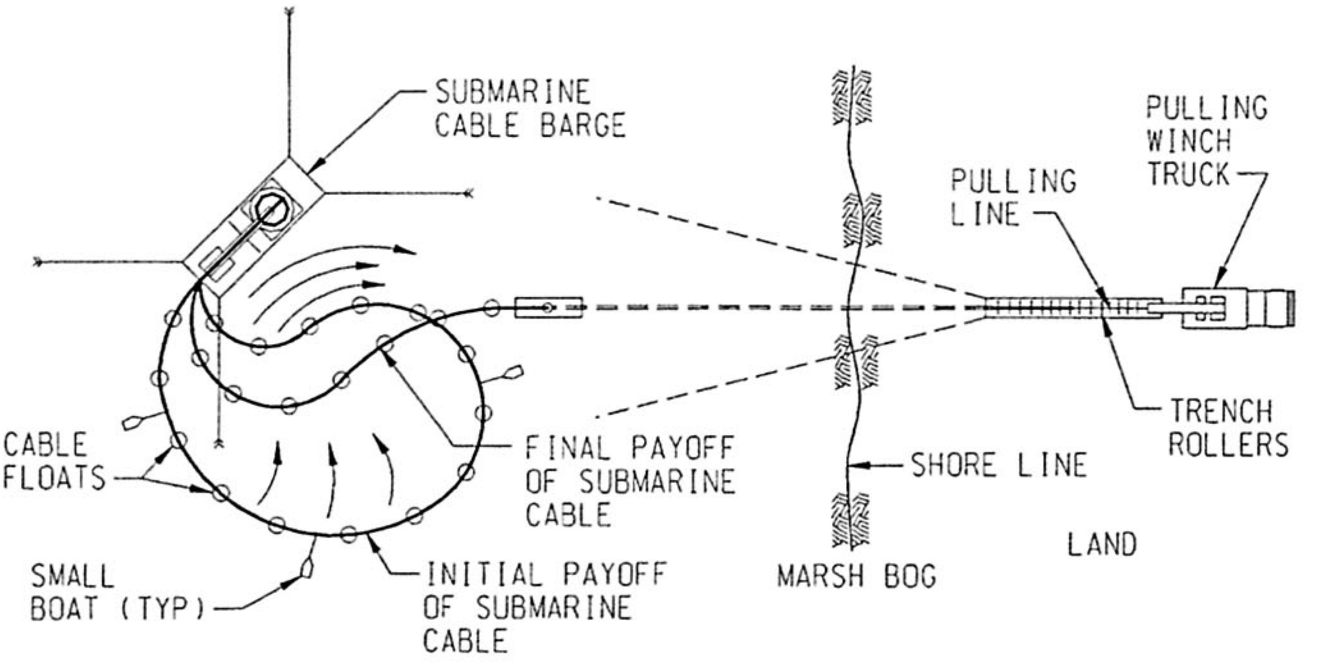
HDD CASING INSTALLATION

JOB NUMBER 120376

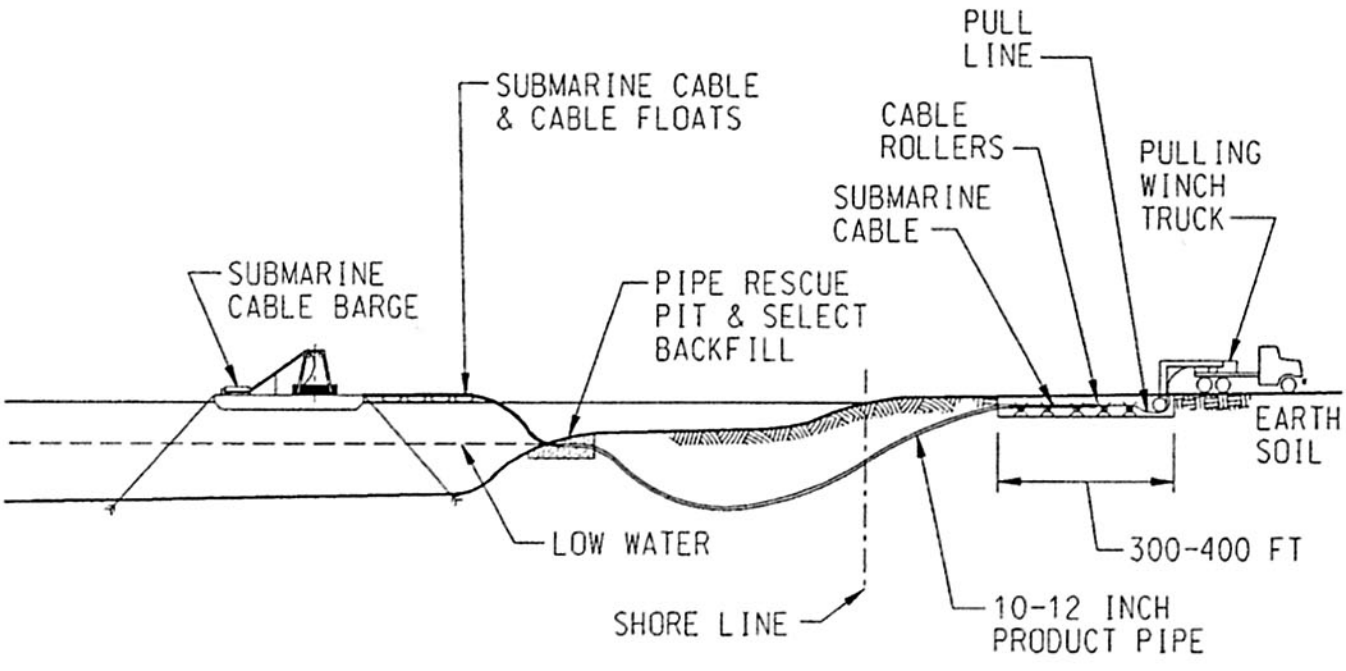
DRAWING NO. Figure B-23

REV A

$$$$SYTIME$$$$$$ hofaz.tbl subm04.dgn



PLAN



PROFILE

STEP 3: SUBMARINE CABLE PAYOFF AND INSTALLATION IN HDD CASING

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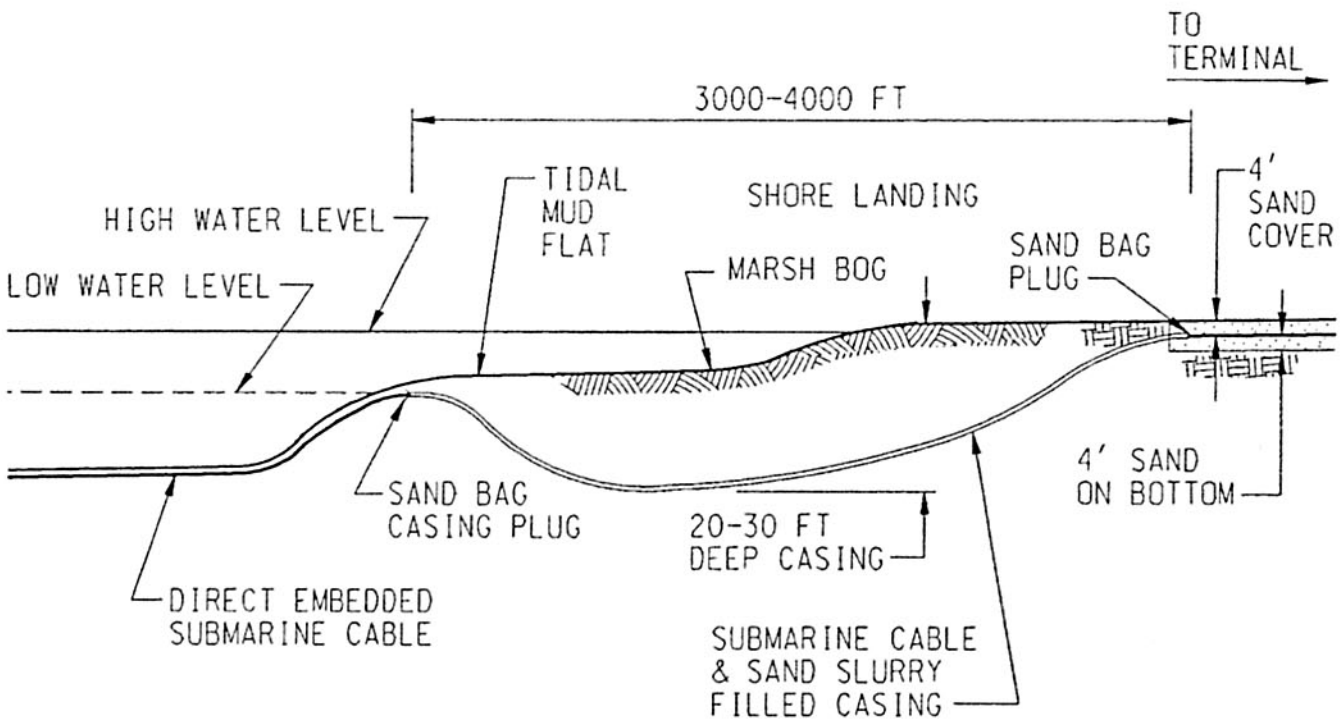
$$$$SYTIME$$$$$$$ | pdfez.tbl | subm05.dgn



PROFILE

STEP 4: FINAL PROFILE OF INSTALLED SUBMARINE CABLE HDD LANDING

DSGN	BH	9/97
DRN	DWN	9/97
CKD	BH	9/97
SCALE: NTS		

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HDD SUBMARINE
CABLE LANDING PROFILE

JOB NUMBER
120376

DRAWING NO. Figure B-25

REV A

$$$$SYTIME$$$$$$$

hdfsz.tbl | submd6.dgn

A substantial amount of the basic data required could be obtained from official sources. The NOAA normally provides assistance with more detailed information concerning the area than that shown on other published charts. Available information may include adequate figures concerning tidal conditions, shipping activities, location of existing pipeline, weather statistics, and water temperature. If so, only a limited number of current and tidal measurements may be needed to verify that the data apply to the precise location of the selected route. It is normal for power cables to link island to island or islands to a mainland by as short of a route as is practical. Consequently, the crossing of a narrow channel can involve working in an area of relatively high tidal currents. These currents could cause movement of the cable and consequential damage. It is therefore essential to know the maximum velocity close to the seabed.

When the prospective routes have been selected it is necessary to prepare profiles of the sea bed. If possible, it is advantageous to record an echo sounding run along each of the specific routes to confirm the correct interpretation of the survey data. A survey of the landing points to determine the conditions and distance between the underwater section of the route and the actual cable terminal on land would complete the overall picture required.

From the full survey data it would be possible to determine the exact length of each route and other features to make an accurate estimate of the cable requirements and allowances for contouring and navigational deviations. The method of cable installation could be determined together with the requirements for the cable laying vessel and other equipment needed to install the cable.

Site Preparation for Submarine Cable Installation

Bow and stern moorings are normally required close to the shore at each end of the route to secure the vessel while the ends of the cable are pulled ashore. The distance of the moorings offshore should be the minimum to ensure the safety of the vessel; their spacing must be adequate to enable all the cables of the system to be handled without repositioning the anchors between each laying operation. Because the handling of the shore ends is a difficult and challenging part of a cable laying operation, it is desirable to minimize the length of cable involved and the time taken during this step at each end of the route.

To prevent the cable from being damaged by tidal action or impacts from floating logs, small boats, or other hazards, it is normal to bury the cable from some distance below the low water mark across the beach to the terminal position.

If the cable is routed through a rocky area where it is difficult to cut a trench of adequate depth, protection may be provided by fitting cast iron cable protectors, pre-cast concrete troughs, or concrete bags.

After the cable transport vessel arrives on site, the cable would be relocated to a cable installation barge using cable-coiling equipment. The normal procedure is for the cable barge and guide ships to practice the process they will use to lay the cable. This includes entering moorings at the starting end, leaving the moorings, navigating along the cable route at cable laying speed, and entering moorings at the finishing end. During this practice, useful records of the seabed profile can be obtained, and the manager of the installation operation and captain of the vessel can become familiar with the special requirements for handling his vessel during cabling operations.

Shore-Tail Installation

Shore-tail installation involves the landing of the submarine cable at the departure and receiving end of the crossing. Installation of the submarine cable at the Turnagain Arm shores would be accomplished by various methods, depending on the specific route selected and the existing conditions at each shore. The installer of the submarine cable system would be responsible for final selection of installation methods.

The following methods would be expected to be used for landing the submarine cable at the water crossing shore-tail:

- conventional trenching
- direct embedment
  - hydraulic pressure jetting equipment
  - marine floor trenching equipment
- horizontal directional drill installation

Conventional Submarine Trenching

Conventional trenching would occur on the Turnagain Arm, Kenai Lowlands, and Anchorage area, and would involve the use of typical excavating equipment to open a trench in the tidal mud flat just before the shore line and in the shore landing area along the submarine cable route. The submarine cable then would be paid-off the cable-laying barge onto cable floats and pulled to shore in line with the open cable trench.

A typical shore-tail submarine cable landing illustration can be found in earlier in Appendix B. The trench would be backfilled and compacted with the spoil from the trench to maintain the same type of fill as found at that location on the beach, and the surface graded to the same slope as existed prior to the installation.

Direct Embedment Submarine Cable Installation

Direct embedment of submarine cable may involve the simultaneous excavation, cable laying, and backfilling as a continuous installation operation. This type of operation involves equipment designed specifically for submarine cable installation. Typically, this type of equipment may be operated on the marine floor, in soft tidal flats above the water level and in soft shore-landing areas. The method of excavation depends on the specific equipment, but this type of installation is generally performed by hydraulic pressure water-jet cutting or belt-mounted cutting teeth on a trench machine arm.

Another method of direct embedment involves the pre-installation of a guideline to help guide specialized embedment equipment. This method requires an initial crossing for each embedment laying of submarine cable but helps ensure that the submarine cable stays on course and proves each course before the cable laying operation begins. Typically, the shore end installation is completed with conventional trenching.

Horizontal Directional Drill Submarine Cable Installation

The HDD shore-tail installation across the ACWR involves more expensive equipment than traditionally used for submarine cable landing activities and more procedures than the previous traditional methods. The HDD method is typically used when conventional excavating equipment cannot be used or if surface obstructions or environmental conditions do not allow surface construction activity. The major steps for installation are as follows:

- Step 1: Installation of Drill String–The HDD equipment drills a catenary-shaped pilot hole from shore to an area up to 3,000 to 4,000 feet into the waterway or tidal flat area.

- Step 2: Pull Back Installation of Product Pipe Casing–The installation of casing pipe involves preparing the casing by welding the appropriate number of pipes into a long continuous segment. The pipe end is then attached to the drill string along with a back reaming head. The HDD rig pulls the drill string and casing back through the pilot hole while back-reaming the hole so it is large enough to accommodate the casing pipe. The casing ends are then positioned horizontally and the submarine cable feed end is fitted with a bell end to accept the pull through of the cable.

- Step 3: Submarine Cable Payoff and Installation in the HDD Casing – This step involves the payoff of the submarine cable from the cable barge and pulling the cable through the HDD casing via pulling line and winch.

- Step 4: Embedment of Submarine Cable at HDD Casing Ends – The submarine cable is buried at each end of the casing. The casing is then filled by pump with a sand slurry and the ends are plugged and the access pits are backfilled.

Tidal Mud Flats Installation Equipment

The tidal mud flat areas of the Turnagain Arm have characteristics similar to a soft shore, consisting of sands, clays, and cobbles. The direct embedment equipment used for the marine floor sediment installation would have the ability to embed the submarine cable in the mud flats during high or low tides. A submarine water jet type excavation machine would be capable of operating in soft soils and relatively loose sediment, although it would be limited by the availability of water supply. A submarine marine floor trenching machine would have better excavation performance in more dense soils. The production rate for embedment would be slower in the mud flats due to the density of the material being excavated. In some cases conventional trenching may be required to properly embed the submarine cable in these areas.

This installation procedure for embedment in the mud flats by direct embedment equipment or conventional trenching would be similar to the shore-tail installation procedures, except for the following differences involving the mud flat installations:

1. The cable barge would pre-lay the submarine cable before embedment/backfill.

2. The trenching installation operation may be interrupted by the tidal flows. The conventional trenching and back hoe would operate from a barge, or drive off a barge on to the mud flat during low tide to perform trenching and the return to the barge and remain idle during high tide.

3. The direct embedment installation operation may be interrupted by the tidal flows. The direct embedment type equipment may need to be anchored or removed and idle during the incoming and ebb tide.

Deep Channel Direct Laying Equipment

The Turnagain Arm waterway has tidal flows in excess of 30 feet. Low tide stages expose approximately 20 percent of the waterway, leaving extensive mud flats. The deep channels of the waterway have currents up to eight knots that do not allow practical submarine cable embedment. Direct lay submarine cable installation is proposed for the deep channels of Turnagain Arm. The direct laying methods of free-boat direct laying and anchor-pull direct laying provides a pictorial representation of each method. Due to strong currents and frequency of the ebb and flood tides, the anchor-pull direct laying method would be expected to be the predominant method of installation in the deep channel areas on this Project.

SUBSTATION

Soil Boring

Soil borings would be made typically at three to four locations in the substation, particularly at the approximate location of large structures and equipment such as transmission line deadends and transformers, to determine the engineering properties of the soil. Borings would be made with truck or track-mounted equipment. The borings would be approximately four inches in diameter, range from 20 to 30 feet deep, and be backfilled with the excavated material upon completion of soil sampling.

Surveying

Surveying would be accomplished by ground survey methods. Surveys would be required to establish property boundaries, existing topographic information, construction baselines, and to stake foundation locations. Survey also may be required for permanent access roads. Section and quarter-section corners would need to be located.

Clearing and Grading

Clearing of all vegetation would be required for the entire substation area including a distance of about 10 feet outside the fence. This is required for personnel safety due to grounding concerns and because of lower clearances to energized conductors in substations as compared to transmission lines. These lower clearances are allowed because the entire substation is fenced.

An insulating layer on the surface of the substation is required to protect personnel from dangerous currents and voltages during fault conditions. Typically, this requires removal of all organic material (vegetation) and a 4- to 6-inch layer of crushed rock is applied to the finished surface of the substation. The substation is then usually treated with a soil sterilizer to prevent vegetation growth, which would degrade the insulating qualities of the crushed rock.

The entire substation area would be graded essentially flat, with just enough slope to provide for runoff of precipitation. The substation would be graded to use existing drainage patterns to the extent possible. In some cases, drainage structures, such as ditches, culverts, and sumps would be required.

Clearing and grading material would be disposed of in compliance with local ordinances. Any material required to be hauled in would be obtained at existing borrow or commercial sites and trucked to the substation using existing roads and the substation access road.

Grounding

A grounding system is required in each substation or reactive compensation site for detection of faults and for personnel safety. The grounding system typically consists of buried copper conductor arranged in a grid system and driven ground rods, typically 8 to 10 feet long. The ground rods and any equipment and structures are connected to the grounding conductor. The amount of conductor and length and number of ground rods required is calculated based on fault current and soil characteristics.

Fencing

Security fencing is installed around the entire perimeter of the substation to protect sensitive equipment and avoid accidental contact with energized conductors. This fence is constructed of chain link with steel posts and is 10 feet high. Generally 1 foot of barbed wire or other similar material is installed on top of the chain link. Locked gates are installed at appropriate locations for authorized vehicle and personnel access.

Foundation Installation

Foundations for supporting structures are of two types—spread footers or augured holes. Spread footers are placed by excavating the foundation area, placing forms, reinforcing steel and anchor bolts, and pouring concrete into the forms. After the foundation has been poured, the forms would be removed, and the surface of the foundation dressed.

Augured foundations are placed in a hole generally made by a truck-mounted auger. Reinforcing steel and anchor bolts are placed into the hole using a truck-mounted crane. The portion of the foundation above ground would be formed. After the foundation has been poured, the forms would be removed, and the surface of the foundation dressed.

Equipment foundations for circuit breakers and transformers would be slab-on-grade type. These foundations are placed by excavating the foundation area, placing forms, reinforcing steel and anchor bolts (if required), and placing concrete into the forms. After the foundation has been poured, the forms would be removed, and the surface of the foundation dressed. Where necessary, provision would be made in the design of the foundations to mitigate potential problems due to frost.

Reinforcing steel and anchor bolts would be transported to the site by truck, either as a prefabricated cage or loose pieces, which would be fabricated into cages on the site. Concrete would be hauled to the site in concrete trucks. Excavated material would be spread at the site or disposed of in accordance with local ordinances.

Structures and equipment would be attached to the foundations by means of the threaded anchor bolts imbedded in the concrete. Some equipment such as transformers and reactors may not require anchor bolts.

Oil Containment

Some types of electrical equipment, such as transformers and some types of reactors and circuit breakers, are filled with an insulating mineral oil. Containment structures are required to prevent oil from this equipment from getting into the ground or waterways in the event of a rupture or leak. These structures take many forms depending on site requirements, environmental conditions, and regulatory restrictions.

The simplest type of oil containment is a pit, of a calculated capacity, under the oil filled equipment that has an oil impervious liner. The pit is covered with metal grating. In case of an oil leak or rupture, the oil captured in the containment pit is pumped into tanks or barrels and transported to a disposal facility. This is the recommended system for this Project.

If required, more elaborate, and more expensive oil containment systems can be installed. This may take the form of an on- or off-site storage tank and/or oil-water separator equipment.

Structure and Equipment Erection

Supporting steel structures are erected on concrete foundations as noted above. These are set with a truck-mounted crane and attached to the foundation anchor bolts by means of a steel baseplate. These structures would be used to support the energized conductors and certain types of equipment. This equipment is lifted onto the structure by means of a truck-mounted crane and bolted to the structures. Electrical connections to the equipment are then made.

Some equipment, such as transformers, reactors, and circuit breakers, are mounted directly to the foundations without supporting structures. These are set in place by means of a truck-mounted crane. Some of this equipment requires assembly and testing on the pad. Electrical connections to the equipment are then made.

Control Building Erection

A control building is required at each substation to house protective relays, control, standby batteries, and remote monitoring equipment. The size and construction of the building depends on individual substation requirements. For this project, pre-engineered steel buildings on slab or pile foundations are assumed. The buildings are manufactured and fabricated at the factory and assembled on site by means of a truck-mounted crane. Once erected, equipment is mounted and wired inside.

Conductor Installation

Two main types of high voltage conductors are used in substations: tubular aluminum pipe and/or stranded aluminum conductor. Tubular conductors are a minimum of three inches in diameter for this project and are supported on porcelain insulators on steel supports. The conductors are welded together and to special fittings for connection to equipment.

Stranded aluminum conductors are used as flexible connectors to certain types of equipment. These are connected to the tubular conductors through special fittings and then connected to the equipment. These are used when equipment connections are not lined-up with the tubular connectors and for seismic considerations.

Conduit and Control Cable Installation

Most pieces of equipment in a substation require low voltage connections to protective relaying and control circuits. These circuits allow metering, protective functions and control (both remote and local) of the power system. Connections are made from the control building to the equipment through multi-conductor control cables installed in conduits and/or pre-cast concrete cable trench.

Construction Cleanup

The cleanup operation would be performed after construction activities are completed. All waste and scrap material would be removed from the site and deposited in local permitted landfills in accordance with local ordinances. Ruts and holes outside the substation fence due to construction activities would be repaved. Revegetation and restoration would be conducted as required.

A permanent access road would be constructed to the site when required. Existing roads and trails would be maintained and repaired as required during use by the construction contractor.

Storage and Staging Yards

Construction material storage yards may be located outside the substation-fenced area in the vicinity of the substation. These storage yards may be part of the substation property or leased by the contractor. After construction is completed, all debris and unused materials would be removed and the staging/storage yards returned to preconstruction conditions by the construction contractor.

Work Force Size

The substations and reactive compensation sites would be constructed under contract by a qualified company experienced in construction of electrical substations. Table B-8 lists typical crew sizes and equipment needed for various construction activities.

TABLE B-8 EQUIPMENT NEEDED FOR SUBSTATION CONSTRUCTION PROCESS			
Construction Activity	**Crews**	**Crew Size**	**Equipment Needed**
Soil boring	1	2-3	Rubber-tired drilling equipment
Surveying	1	2-3	Pickup truck
Clearing and grading	1-2	3-4	Hydroaxe, chainsaw, bulldozer, loader, grader, pick-up truck
Grounding	1	2-4	Trencher, pick-up truck
Fencing	1-2	2-4	Small auger, concrete truck, pick-up truck
Foundation installation	1-2	2-4	Rubber-tired auger, truck mounted crane, concrete trucks, backhoe, loader, pick-up truck
Oil containment	1	2-4	loader, backhoe, pickup truck
Structure and equipment erection	1-2	3-4	Crane, pickup truck
Control building erection	1	3-4	Crane, pickup truck
Conductor installation	1-2	2-3	Welder, crane, bucket truck, pickup truck
Conduit and control cable	1-2	2-3	Trencher, pickup truck
Cleanup	1	2-3	Pickup truck